(Established 1832.)
AMERICAN ENGINEER AND RAILROAD JOURNAL

JUNE, 1906.

THE MECHANICAL DEPARTMENT HAS A FUTURE.

BY G. M. BASFORD.

"The colleges do some good—they keep some of the lightweights out of the railroad business." This cynical remark by Hiram Bolton in the "College Widow" suggests a question which is rather important at the present time. This is: How shall the bright young man get into the railroad business? Another is: How shall he be kept in the railroad business?

Railroad work presents too many distinct fields to permit of any general statement which will cover them all, but some remarks concerning the motive power department as a field for young men seem to be necessary just now.

At this time of year it is not unusual to find posted on the bulletins of the various technical schools, giving especial attention to engineering work, a number of letters from large industrial establishments and railroads indicating a desire to secure college men for subordinate positions, incidentally implying most brilliant promises for the future. The boys are stirred up by these prospects; they are anxious to start in the game of life, and at this point they are in great danger of being wrongly impressed with their importance. They are led to believe that the world has been expecting them for some time and is ready to offer most extraordinary advantages, from which they have only to select the best in order to be sure of success. Some of these bulletins are followed up by representatives of the companies, bringing lantern slides, and even moving pictures, showing the interesting character of the work which the young recruits take up, and these representatives have been known to promise certain definite salaries at the end of specified periods.

The young men are misled. They get a wrong idea of life from the large number of invitations presented just at this impressionable stage, and they are likely to believe that the education which they have just "completed" is to keep before them always a large number of brilliant opportunities from which they have only to select the best, as they may at the outset. As a matter of fact, no such array of opportunities ever appears before the college man at any other period in his career after he once gets to work—at least it never comes until the young man's record has been made by his work, so that he is widely known to be able to do certain things which people want done.

Nearly all of the concerns and railroads offer the young men what is called "Special Apprenticeship." This is believed to be a mistake, and the present situation of college men on railroads would seem to be abundant evidence that a better way is needed to bring these young men into contact with the railroad problem. Other reasons why it is a mistake have been presented in these columns, but it is sufficient to say that this method discourages the young men by placing them at a disadvantage because of a lack of experience involving personal responsibility. That, alone, is enough to suggest seeking after an improved method. "Special apprenticeship" is too slow. It tends towards superficial experience. A "special" apprentice does not encounter responsibility at the beginning, and, at the end of a period of perhaps three years it is necessary for him to again begin at the bottom.

There never was a period in the history of the railroads when experienced and well-prepared young men were as greatly needed in the motive power department as they are to-day. There never was a time when so many important problems confronted the man capable of contributing to the development of the locomotive. When in the past have so many questions, as—the big locomotive, compound locomotives, stokers, superheating, balancing, improved valve gear, articulated construction, feed water heaters, variable exhaust nozzles, combustion chambers, motor cars, and the various shop problems of the present time, faced the railroad officer? And at what period of the past has development been so rapid as it is at the present time? One who attempts to analyze the motive power possibilities and the opportunities of the motive power officer to aid in the great problem of transportation, will be convinced of the fact that the motive power officer of the future must be a bigger man than the one of the past, because, thus far, only the surface of the possibilities has been scratched. The motive power officer has not yet begun to show how he can affect the efficiency of operation.

This means that the railroads will need to develop young men as rapidly as possible; and, if the time-honored methods of recruiting them have proved to have failed—as they seem to have done—it is time that something better was tried. The simplest way, and the one which seems to promise most, is to take young men from college into the service as workmen, allowing them to carve their own way from the very first, insisting that as far as possible only those will be taken into regular service who have had some practical shop experience. (Even that which may be obtained during vacations is a great help.) By putting these young men upon their own responsibility at the outset they will develop with the greatest possible rapidity.

The college professors of the present time may be said to feel doubtful of railroad work as a promising field for their product—and, after looking over the situation carefully, they cannot be blamed for this opinion which is rapidly becoming a conviction. Undoubtedly improved methods may be introduced for starting the young men in their careers, but it is equally important that improved methods be adopted for retaining them. Once these young men are in the service the real trouble begins, because their value increases so fast as to render it difficult to keep them in the service.

The matter of compensation is large enough for a discussion of its own. It is sufficient to say that the railroads should offer a living wage to the young men and that the young men should be glad to secure a living wage. They should then be advised not to think of the matter of compensation until after several years—say—five years, of service. After that time, they have usually had a most excellent experience and are wanted by every sort of industrial establishment because of the valuable experience which the railroad service has given them. At such a time a little encouragement is necessary, and there should be someone in the mechanical department of the railroad who has time to give it. Many young men have gone into the most difficult part of the motive power field—the round house—and have served faithfully for a sufficient length of time to fix their value to the road and have then been enticed away because of the apparent lack of future and because of inducements offered elsewhere. There really is no lack of future on a railroad for those who are content to wait and who occupy themselves in the right way while they wait. But, it is a fair question to put to any railroad official—whether the apparent outlook for a young college man who has "made good" in the management of men in such a difficult position as that of a round house foreman, is sufficiently bright to lead him over the critical period which precedes the real beginning of his advancement. Once past the round house stage, the young man may by careful treatment, be permanently preserved to the service; and it is right at this point of his experience that he needs the encouragement which he would receive in being assured that he has a future on the road.

The young men are a little too impatient. They, as a rule, need the advice of someone to whom they will listen and

who will tell them to be patient. The college professor needs the co-operation of railroad officials so that the preparation of the students may be intelligently conducted. And, the railroads need to be shown that in the future they are going to need technical men more than they have in the past and that the interest in railroad work will not, of itself, attract young men or hold them against the competition of industrial establishments where they appear, at the present time, to be better appreciated.

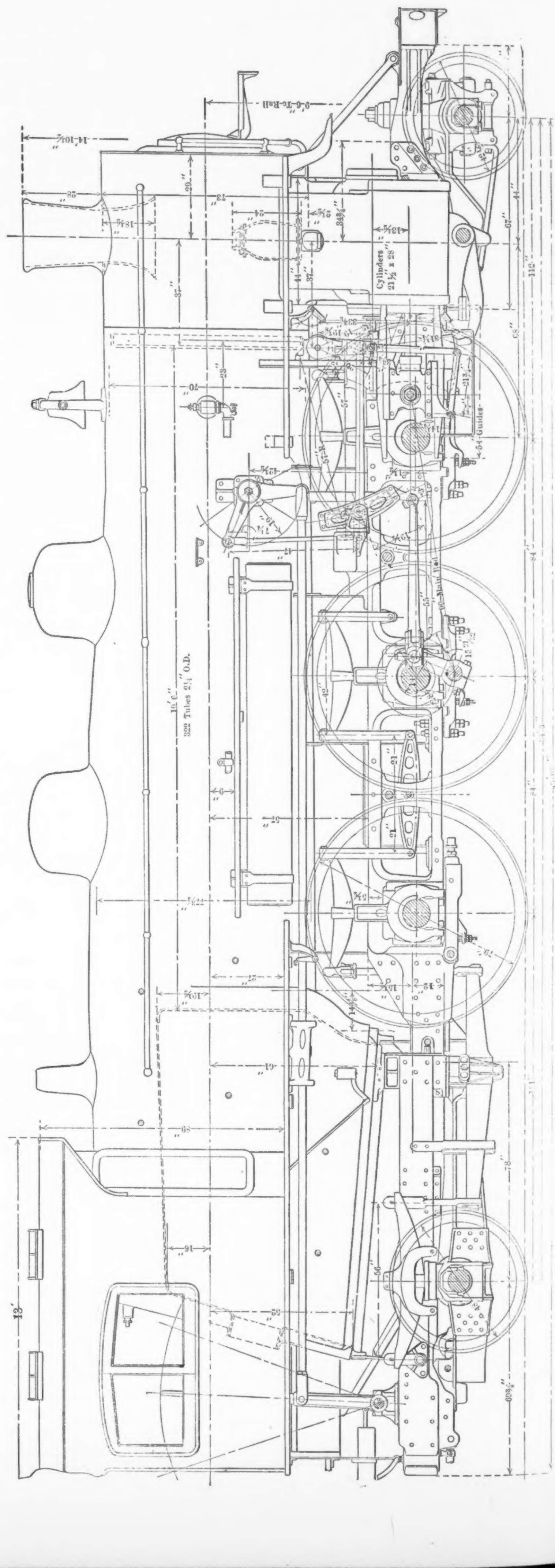
The young college men who enter railroad work with the determination to see it through, and who are patient enough to stick until they are absolutely required—as they will be—for important positions, will, themselves, improve these conditions. There is no better field to-day for the young man who is mechanically inclined and can manage men than the motive power field, and none in which better records are to be made by young men who are properly prepared to make them.

The young men who are prepared to "butt in" and "look for trouble" and who appreciate the importance of preparation coupled with patience are sure to be glad that they entered railroad service. In time, they will, themselves, exert a powerful influence in removing the difficulties and discouragements which now surround the motive power officer.

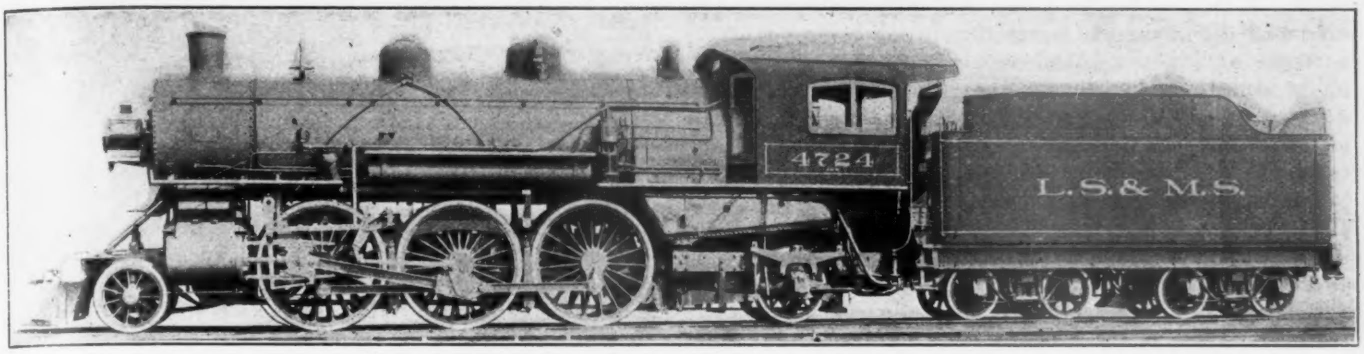
THE SUCCESSFUL FOREMAN.—To sum up—the successful general foreman must be a hustler, a man who can enthuse life into his foremen so that they will keep their shoulders to the wheel and keep things moving. The most skilful foreman is not always the one that has exceptional mechanical ability. While exceptional mechanical ability is desirable, it is also necessary that a foreman be able to take a bird's-eye view of the situation. A man is needed who can keep the continuity of the work in his mind and bring the various factors together, so that they will work out harmoniously, both as to construction and time. This qualification is especially desirable when one foreman's work is dependent upon another's. The foreman who possesses these qualifications can truly be said to be successful.—*Mr. Lee R. Laizure, International Railway General Foremen's Association.*

COST OF REPAIRS PROPORTIONAL TO ORIGINAL COST.—My experience is that engines cost to repair in similar service, very nearly in proportion to their original cost or to the traffic they handle —it does not make much difference. We keep a $10,000 locomotive in repair at 4 cents per mile. We can keep $10,000 worth of freight cars in repair at 4 cents a mile. The rule may not always hold, but it comes to about the same thing. Equipment of the same value will cost about the same to keep up, and it does not seem to me that electrical equipment is going to be very much different.—*H. H. Vaughan, New York Railroad Club.*

COMPOUND FREIGHT LOCOMOTIVES.—It seems to me, aside from any question of fuel economy, cost of repairs or reliability, the fact that a fireman can come nearer making a heavy compound engine haul its calculated rate than he can a simple, is sufficient argument for compounding heavy freight engines.—*D. Van Alstyne, before the Western Railway Club.*



SIMPLE PRAIRIE TYPE PASSENGER LOCOMOTIVE.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.



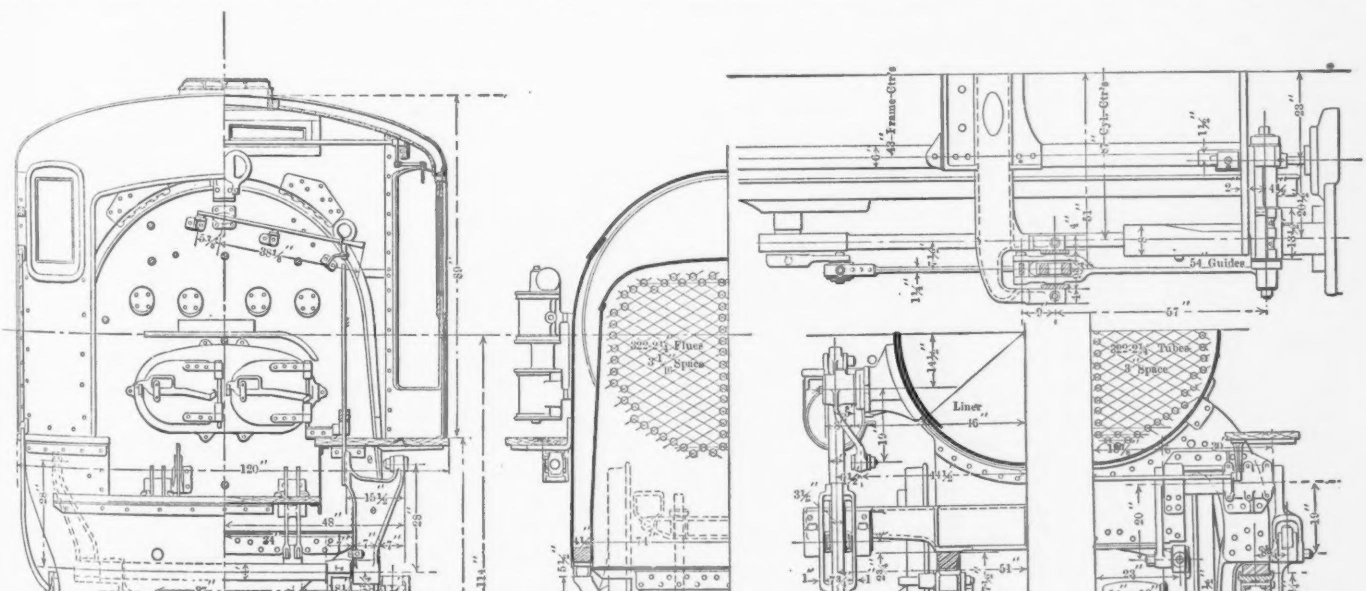
HEAVIEST PASSENGER LOCOMOTIVE, LAKE SHORE & MICHIGAN SOUTHERN RY.

PRAIRIE TYPE PASSENGER LOCOMOTIVE WITH WALSCHAERT VALVE GEAR.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

About a year and a half ago the Lake Shore & Michigan Southern Railway put into service some very powerful and incidentally handsome locomotives of the Prairie type, which were at that time the heaviest passenger locomotives ever built. These engines were thoroughly illustrated and described in the AMERICAN ENGINEER AND RAILROAD JOURNAL, November and December, 1904, and January, 1905.

Recently it has become necessary to order more locomotives of this type, and in view of the excellent satisfaction which had been given by the previous engines, it was decided to practically duplicate that design in essential details, and an order was given to the American Locomotive Company for the engines, which are illustrated herewith, and which, in regard to total weight and weight on drivers, are the heaviest



SECTIONS AND VALVE GEAR, PRAIRIE TYPE LOCOMOTIVE, L. S. & M. S. RY.

passenger locomotives that have ever been constructed, weighing, as they do, nearly 245,000 lbs. total and 170,000 lbs. on drivers.

This order forms the third class of Prairie type engines in use on this road for fast passenger service, the first of which were put into service early in 1901. Each new class has been designed in view of the experience with the previous one, and it speaks exceedingly well for those already in use that it has been found necessary to make so few changes in this last order. The following table shows the general dimensions of each of the three, as well as the ten-wheel passenger engine which immediately preceded them:

	F-52	J-40	J-41	J-42
	4-6-0	2-6-2	2-6-2	2-6-2
Total weight	172,500	174,500	233,000	244,700
Weight on drivers......	135,000	130,000	165,200	170,000
Tractive effort	23,500	24,700	27,850	27,850
Size cylinders	20 x 28	20½ x 28	21½ x 28	21½ x 28
Dia. drivers	81	81	79	79
Total heating surface....	2862.5	3,362	3,905	3,905
Grate area	36.6	48.6	55	55
Reference in American Engineer	1899 p. 343	1901 p. 69	1904 p.413	1906 p. 203

The principal changes which have been made in the former design are the application of the Walschaert valve gear in place of the Stephenson, and the use of a radial outside bearing trailer truck. This company has had considerable experience with Walschaert valve gear in freight service, it being the pioneer in the use of this design, which is now becoming very popular in this country, and this experience has been so satisfactory that it was decided to extend its use to passenger locomotives. In making the application it was necessary to rearrange but a small number of parts in the previous design, and the cylinders, guide yoke and guides were allowed to remain as they were, a separate steel casting being designed to span the frame between the first and second pair of drivers and support the link of the Walschaert gear. Inasmuch as a valve chamber over the frames is used, it was necessary to transmit the motion to a rocker placed on the frame just behind the cylinders and operating the valve stem through a crosshead connection. The bell crank used for re-

versing is fastened to the boiler shell with the vertical arm extending downward and connecting to the reverse shaft by a reach rod. Part of these engines have the reverse shaft in its usual location, between the second and third pair of drivers, and part of them with it across the frames at the rear of the firebox, in which case there are two reach rods extending forward.

The design of the outside bearing trailer truck, which employs two slab frames at the rear, one inside and one outside the wheel and the radius bar connected to the cross casting at the front of the firebox, is clearly shown in the illustration.

The boiler is an exact duplicate of the one used on the previous engines, as are also the wheels and other important details.

All of these additions have increased the weight of the engine, making it nearly 12,000 lbs. heavier than the previous design. This, as above mentioned, makes them the heaviest passenger locomotives in the world. In the following table are given six of the recent heavy passenger locomotives of the Prairie and Pacific types, with the principal ratios of each, by which comparison can be made with this large machine.

	L.S.&M.S. 2-6-2	P. R. R. 2-6-2	Erie. 4-6-2	B. & O. 4-6-2	A.T.&S.F. 4-6-2	N. Y. C. 4-6-2
Total weight, lbs.	244,700	234,500	230,500	229,500	226,700	218,000
Weight on drivers, lbs.	170,000	166,800	149,000	150,500	151,900	140,500
Size, cylinders, ins.	21½x28	21½x28	22½x26	22x28	17&28x28	22x26
Diameter, wheels, ins.	79	80	74	74	73	75
Tractive effort, lbs.	27,850	27,520	30,260	31,100	32,800	28,500
Total heating surface, sq. ft.	3,905	3,876	3,322	3,417.6	3,595	3,758
Tube heating surface, sq. ft.	3,678	3,677	3,119	3,234.6	3,402	3,554
Firebox heating surface, sq. ft.	227	198	202	183	193	204
Grate area, sq. ft.	55	55	56.5	56.5	54	50
Tractive effort ÷ total heating surface	7.13	7.1	9.1	9.1	9.1	7.6
Weight on drivers ÷ tractive effort	6.1	6.05	4.93	4.84	4.62	4.93
Total weight ÷ tractive effort	8.8	8.5	7.6	7.4	6.9	7.65
Tractive effort x diameter drivers ÷ heating surface	563	568	672	672	670	569
Total heating surface ÷ grate area	71	70.5	58.8	60.5	66.5	75
Firebox heating surface ÷ tube heating surface, per cent	6.17	5.5	6.5	5.68	5.67	5.75
Weight on drivers ÷ total heating surface	43.6	43	44.9	44	42.2	37.4
Total weight ÷ total heating surface	62.7	60.5	69.5	67	63	58

For details of the boiler, cylinders, frames, etc, reference can be made to the drawings published with the description of the previous engine. The general dimensions and weights of this new order, which in the railroad's classification are known as Class J42, are as follows:

SIMPLE PRAIRIE TYPE LOCOMOTIVE WITH WALSCHAERT VALVE GEAR—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

GENERAL DATA.

Gauge	4 ft. 8½ ins.
Service	Passenger
Fuel	Bit. coal.
Tractive power	27,850 lbs.
Weight in working order	244,700 lbs.
Weight on drivers	170,000 lbs.
Weight of engine and tender in working order	403,700 lbs.
Wheel base, driving	14 ft.
Wheel base, total	34 ft. 3 ins.
Wheel base, engine and tender	62 ft. 5½ ins.

CYLINDER..

Kind	Simple.
Diameter and stroke	21½ x 28

VALVES.

Kind	Piston
Diameter	12 ins.
Greatest travel	6 1-16 ins.
Outside lap	1¼ in.
Inside clearance	⅛ in.
Lead in full gear	7-32 in.

WHEELS.

Driving, diameter over tires	79 ins.
Driving, thickness of tires	3½ ins.
Driving journals, main, diameter and length	10 x 12 ins.
Driving journals, others, diameter and length	10 x 12 ins.
Engine truck wheels, diameter	42½ ins.
Engine truck, journals	6½ x 12 ins.
Trailing truck wheels, diameter	48 ins.
Trailing truck, journals	8 x 14 ins.

BOILER.

Style	E. W. T.
Working pressure	200 lbs.
Outside diameter of first ring	70 ins.
Firebox, length and width	108 x 73 ins.
Firebox plates, thickness	⅜ & ½ in.
Firebox, water space	4 & 4½ ins.
Tubes, number and outside diameter	322-2¼ in.
Tubes, length	19 ft. 6 ins.
Heating surface, tubes	3,678 sq ft.
Heating surface, firebox	227 sq. ft.
Heating surface, total	3,905 sq ft.
Grate area	55 sq ft.
Smokestack, diameter	18 & 21¾ ins.
Smokestack, height above rail	14 ft. 10½ ins.

TENDER.

Tank	Water-bottom
Frame	13 in. channel.
Weight	159,000 lbs.
Wheels, diameter	36 ins.
Journals, diameter and length	5½ x 10 ins.
Water capacity	7,000 gals.
Coal capacity	15 tons.

Training of Laborers.—In investigations conducted by Mr. Frederick W. Taylor it was found that most laborers waste considerable of their effort by false moves. For example, in unloading pig iron from a car, which work requires the lifting of pigs weighing, say, about 90 lbs., carrying them to the edge of the car and throwing them overboard, there was found to be a lack of continuous effort. The laborer would stoop down, pick up the pig, stand for a moment and then start for the side of the car. It was suggested that the movements should be co-ordinated so that the impulse required to pick up the pig should be continued until it was dropped over the side of the car. The surprising result was found that where an ordinary laborer had been able to handle only about twelve tons per day, under the new system he handled about forty-eight tons per day. Again, in the matter of shovelling coal, the shape of the shovel and its size were found to be very important factors, and by studying the problem the amount of coal that could be handled by the average laborer with no greater tiring than before was greatly increased. From this experience it is quite evident that the training of laborers may be quite as important as the training for the so-called trades. The training of the laborer, of course, will be more that of muscle training than of brain training, but it is nevertheless quite as important in the cost of production where large quantities of materials must be handled by manual labor.—*Machinery.*

Proposed American Railway Congress.—Mr. L. C. Fritch, assistant to the general manager of the Illinois Central Railroad and formerly secretary of the American Railway Engineering and Maintenance of Way Association, has developed a plan for the union of the American Railway Association, Master Car Builders' Association, American Railway Master Mechanics' Association and the American Railway Engineering and Maintenance of Way Association into one representative body. It is claimed that such an organization could do better and more effective work than is possible with the four separate organizations. The proposed congress would be divided in three sections: transportation, maintenance of way and maintenance of equipment.

Limitation of Big Locomotives.—There has been a good deal said and written lately about the inability of the big engine to haul its theoretical rating. There are several reasons for this failure to get the most out of the big engine, the principal one of which perhaps is the inability of the fireman to maintain steam, or, in other words, the hauling capacity of the big engine is, to a considerable extent, measured by the firing capacity of the fireman.—*D. Van Alstyne, before the Western Railway Club.*

LOCOMOTIVE PERFORMANCE SHEETS.

BY H. H. VAUGHAN.

The immediate intention of a performance sheet is familiar to all mechanical and operating officers. Following the information obtained as to the expenditures on a road or a division for repairs, fuel, oil and waste comes the desire to compare the expenses of individual engines in order to ascertain whether one is more extravagant or economical than another, in one or all of these items, or to watch the results obtained on any engine from month to month. Beyond this reason there is another which is of greater importance—the presentation to the men operating and maintaining the engines of the work they are performing in a sufficiently clear and apparent manner to incite them to improvement or to call attention to wasteful handling, or to engines that are defective or unnecessarily expensive.

While the object to be attained by a performance sheet is evidently desirable, and few will question the possibilities of saving in expenses which would result from its realization, it is doubtful whether such sheets, as frequently arranged and issued, are really of vital interest to the men in general. In the first place, since they include the cost of repairs each month, they cannot be issued on most roads until the monthly accounts are closed, and as accounting offices are frequently busy at that time in furnishing general statements for executive officers, which are wanted as quickly as possible, the performance sheets are allowed to take their place and issue from four to five weeks after the end of the month they refer to. In the second place, their arrangement while sufficient to present the information they contain, is not designed to indicate without considerable study which engines attain the better and which the worse results; neither do they in general furnish sufficient information to enable their user to draw his conclusions without obtaining further details.

While there is a considerable variation on different roads, what may be termed a general type of performance sheet would show on one page information for each engine, under columns headed about as follows:

Engine number.	Miles, total.
Class.	Tons hauled one mile.
Type.	Coal, tons.
Working between.	Engine oil, pints.
Engineers.	Valve oil, pints.
Miles, train.	Illuminating oil, pints.
Miles, light.	Waste, pounds.
Miles, doubling or assisting.	Cost of repairs.
Miles, switching.	

Amount or cost of these items used per locomotive mile and per 1,000-ton mile.

The above sheet would be issued separately for passenger, freight and work service, in which case an engine might appear on two sheets or combined when the mileage in the different services may be subdivided in the mileage columns, but it is not then usual to subdivide the coal used.

While this type of sheet is termed general, no statement is intended that it is universal, although a somewhat similar arrangement was extensively in use some years past. While containing valuable information, it is, however, open to the objections previously recited, and as an attempt has been made on the Canadian Pacific to compile the figures in a manner that will appeal more definitely to the men concerned, the sheets in use on that road will be described to illustrate what is considered a preferable arrangement.

The general performance sheet actually contains information about three items—coal, oil and repairs—and, as previously stated, the repairs are the chief cause of the delay in the issuance of the figures. Coal figures, to be of value, must be promptly published, as it is impossible for men to account for an excessive consumption that occurred some weeks previously, and the same remarks apply to those for oil. Repairs, coal and oil also require the engines to be differently grouped for convenient comparison. For these reasons the sheet has been subdivided into three to show the performances for coal, oil and repairs separately.

The coal sheet is issued bi-monthly in place of monthly, as this has been found preferable. When first introduced it was made up weekly, but the objections developed that the work done by the engines was hardly sufficient to arrive at satisfactory average figures, and the work of looking into the reasons for poor results, or, indeed, of going over the sheets thoroughly, was too great. In order to obtain the figures promptly an accounting force was installed at each division headquarters, and the coal records are now in the hands of the motive power department within a week or ten days of the close of the period they cover. An example of the coal performance sheet is shown above.

It will be seen that each run between terminals is shown separately, and freight, way freight and passenger results are also separated. Each group of engines is totalled, and those in each group are divided to show which are better and which worse than the average of the group. The column headed "average load per mile" has been introduced to allow for the variation in loads in direction contrary to traffic or fast running, as were the results subdivided into east and west bound, it would necessitate an accurate measure of the coal on the tender, which is under this plan less important, although

CANADIAN PACIFIC RAILWAY COMPANY

Performance of Locomotives, Lake Superior Division, Period Ending April 20, 1906.

Running between Chalk River and North Bay, Distance between Terminals 118 Miles.

Class of Service.	Loco. No.	Haulage Capacity Per Cent.	Local Miles.					Gross Tons Hauled One Mile.	Coal Consumed Tons.	Coal Consumed Per Unit Mile.		
			Train.	Light.	Doubling or Assisting.	Switching.	Total.			Average Load Per Mile.	Better than Average.	Worse than Average.
Freight	67	60	13	13	....	....	26	5,221	¾	....	....	....
	630	100	472	5	5	....	482	276,611	31¾	574	230	....
	740	155	1,278	24	4	....	1,306	1,124,478	81	861	144	....
	741	155	236	....	....	....	236	188,823	12¾	800	135	....
	757	155	702	....	....	6	708	658,229	43½	930	132	....
	760	155	1,298	121	3	27	1,449	1,171,484	83½	808	143	....
	761	155	1,180	7	7	....	1,194	1,077,335	75⅝	902	141	....
	762	155	590	121	3	....	714	488,641	36¾	684	....	150
	763	155	944	19	20	....	983	844,520	69¼	859	....	164
	764	155	236	....	....	....	236	176,840	14¾	749	....	167
			6,464	292	37	33	6,826	5,730,350	417¼	839	146	....

Note.—"Gross Tons Hauled One Mile."—Actual for Passenger; Equivalent for Freight and Mixed; including allowance for Road Switching at rate of 200 tons per mile for Passenger and Mixed, and 300 tons per mile for Freight Trains.

"Coal Consumed per Unit Mile."—"Unit Mile" represents 1,000 tons hauled one mile.

even now an engine working both ways out of a terminal occasionally shows bad results in one direction and good in the opposite.

The oil and waste performance sheet is shown below.

This sheet is issued monthly for each division, and the engines are simply arranged in numerical order. The figures for headlight, signal oil and waste are shown in the usual way by the number of miles run per pint or pound, but those for engine and valve oil are calculated rather differently. It is the custom for each engine to be allowed a certain number of miles per pint, according to its class. Should an engine thus run on its allowance, it has evidently equalled the number of miles per pint called for on the schedule for its class, and by showing on this form the amount and percentage by which each engine has exceeded or run within its allowance, those using the greater are clearly divided from those using a lesser amount per mile, whereas when these figures are shown by miles per pint, it is necessary in criticising them

CANADIAN PACIFIC RAILWAY COMPANY

ONTARIO DIVISION

Oil and Waste Performance of Locomotives, February, 1906.

Loco. No.	Type.	Mileage.	ENGINE OIL.					VALVE OIL.					HEADLIGHT OIL.		SIGNAL OIL.		WASTE.		Other Supplies Value.
			Allowance Pints.	Issued Pints.	Excess Pints.	Credit Pints.	Excess or Credit Per Cent.	Allowance Pints.	Issued Pints.	Excess Pints.	Credit Pints.	Excess or Credit Per Cent.	Issued Pints.	Miles Run to One Pint.	Issued Pints.	Miles Run to One Pint.	Issued Pounds.	Miles Run to One Pound.	
TLE:P3	8 W	3,710	92¾	66½	....	26¼	28	26½	33	6½	....	24	30	124	8	464	10½	353	....
C. P. 95	"	3,749	93¾	83	....	10¾	11	26¾	28	1¼	....	5	48	78	12	312	3	1,250	3.44
145	"	1,858	46½	68	21½	....	46	13¼	20½	7¼	....	55	56	33	8	232	8	232	.06
186	"	380	9½	10¼	¾	....	8	2¾	4	1¼	....	45	26	15	2	190	¾	507	12.55
188	"	3,230	80¾	96	15¼	....	19	23½	25	1½	....	6	80	40	7	461	11	294	1.13
203	10 W	4,441	148	160½	12½	....	8	44½	52	7½	....	17	20	222	7	634	5¾	772	3.12
205	"	4,370	145½	152	6½	..	4	43¾	50½	6¾	....	15	16	273	8	546	5	874	.43
220	"	4,254	141¾	144	2¼	....	2	42½	45	2½	....	6	28	152	9	473	5	85	4.30
257	8 W	3,456	86½	72	....	14½	17	24¾	24	....	¾	3	24	144	6	576	18	192	

CANADIAN PACIFIC RAILWAY COMPANY

MONTHLY STATEMENT OF COST OF RUNNING REPAIRS

Atlantic Division. Contd.

Month Ending February, 1906.

Engine No.	Headquarter Station.	Month of February											Total to Date						
		LAST REPAIR.		Rate.	COST.				Mileage	Per Mile.	Excess.	Decrease	Mileage. from No. 1.	COST.			Per Mile.	Excess.	Decrease
		No.	Mileage.		B. W.	O. W.	Defect.	Total.						B. W.	O. W.	Total.			
541	Woodstock	....	....	2.0	.34	128.15	....	128.49	2,745	4.69	73.69	....	32,854	....	....	903.17	2.75	249.09	....
542	Woodstock	....	....	2.0	....	33.39	....	33.39	4,045	.83	....	47.51	35,161	66.41	635.66	702.07	2.0	....	1.15
613	McAdam	2	955	2.0	7.42	35.42	....	42.84	2,212	1.93	....	1.40	47,285	27.13	612.99	640.12	1.35	....	304.58
616	Brownville	....	....	2.0	7.72	77.09	....	84.81	3,723	2.28	10.35	....	48,499	23.64	695.74	719.38	1.48	....	250.60
634	Bay Shore	....	....	2.0	....	32.33	....	32.33	2,766	1.17	....	22.99	644	....	25.83	25.83	4.0	12.95	....
D 1-3	....	....	....	....	15.48	306.38	....	321.86	15,491	2.08	12.04	....	....	....	....	....	....	....	....
930	Brownville	....	....	2.7	....	4.15	....	4.15	123	3.37	.83	....	45,322	56.32	1,069.80	1,126.12	2.49	....	94.12
933	Brownville	....	....	2.7	.30	149.50	....	149.80	4,823	3.11	19.58	....	34,657	34.71	800.96	835.67	2.41	....	100.06
945	Brownville	....	....	2.7	9.33	137.96	....	147.29	4,137	3.57	35.60	....	26,855	43.15	754.47	797.62	2.97	72.54	....
970	McAdam	....	....	2.7	.67	90.57	....	91.24	4,652	1.96	....	34.36	24,233	25.19	353.52	378.71	1.56	....	275.57
985	McAdam	2	22,638	2.7	3.61	91.70	....	95.31	4,607	2.07	....	29.08	49,885	....	....	1,604.73	3.21	258.86	....
992	McAdam	2	22,544	2.7	5.69	118.55	....	124.24	4,543	2.74	1.58	....	46,694	52.70	1,250.65	1,303.35	2.8	42.63	....
D 6	....	....	....	....	19.60	592.43	....	612.03	22,885	2.68	....	5.85	....	....	....	....	....	....	....

to know how much each engine should properly consume in order to so separate them. A column is also introduced on this sheet to show the value of the "other supplies" charged to each engine, which enables a watch to be kept on this item without complicating the coal and repair statements.

The repair statement, shown on opposite page, includes only running repairs, which on this road are defined as those costing under $100 for labor. Shop repairs are analyzed entirely separately and without reference to the monthly mileage, so that they don't come within the scope of a performance sheet. This form requires some explanation. It is made up by divisions, and on each division the engines are arranged by groups of one or more classes. The headquarter station is the point out of which the engines were running during the month, as all engines are assigned to some terminal, the other end of the run being considered a turn-around point as far as possible. The column "last repair" shows the class of machinery repairs last received, and the mileage made at that time since last general overhauling of machinery. If not filled in, the engine has received no shop repairs since its last general or No. 1 machinery. The rate is an arbitrary figure, based upon the tractive force which is partially intended to set a cost at which the engines should be maintained, but more to divide them into those which are above and below it. On the Northern Pacific, where a very similar sheet is employed, of which this is a modification, the rate is determined from the actual cost over several previous years, which has the advantage of demonstrating that the engines could be maintained at the rate set. On the Canadian Pacific, in view of the importance of the tractive power mile, that being the figure on which the general maintenance account is criticised, it is preferable to base the rate or allowance on the same unit, as it can then be determined which groups or divisions have increased or decreased the general cost. The factor on which the rate is based is really not important, provided the results are not all above or all below it, and the one shown, which is based on one cent per 1,000-lb. tractive power mile, is satisfactory in that respect. The Columns "B. W." and "O. W." show respectively the cost for boiler work and other work, a separation that is important in making comparisons between divisions on which the quality of water varies, and that headed "defect" is to record the cost of repairs, such as broken piston rods, crankpins, etc., for which the division is not actually responsible, but which do not come under the head of wreck damages. The columns "excess" and "decrease" show the amount by which the repairs exceed or are below the allowance based upon the rate and the mileage, and, together with that headed "cost per mile," enable the results to be taken in at a glance. The figures all apply to the results for the month, but, as is well known, one month's results even on running repairs vary to a great extent on the same class of engine and service. The general touch up given an engine when receiving a staybolt test may run that month's expenses up, but reduce the costs for the next sixty days, and it is therefore necessary not only to know what an engine has cost in one month, but how much it has cost during a considerable period before drawing any conclusions. To show this the figures under "Total to date" have been introduced. These show the mileage made, costs, etc., since the engine last received a No. 1 or general overhauling of machinery to the end of the month preceding that for which the sheet refers to. The reason for not including the last month is to enable these figures to be made out and entered on the form in advance of the receipt of the monthly reports, which reduces the time required to write out and distribute the performance sheet.

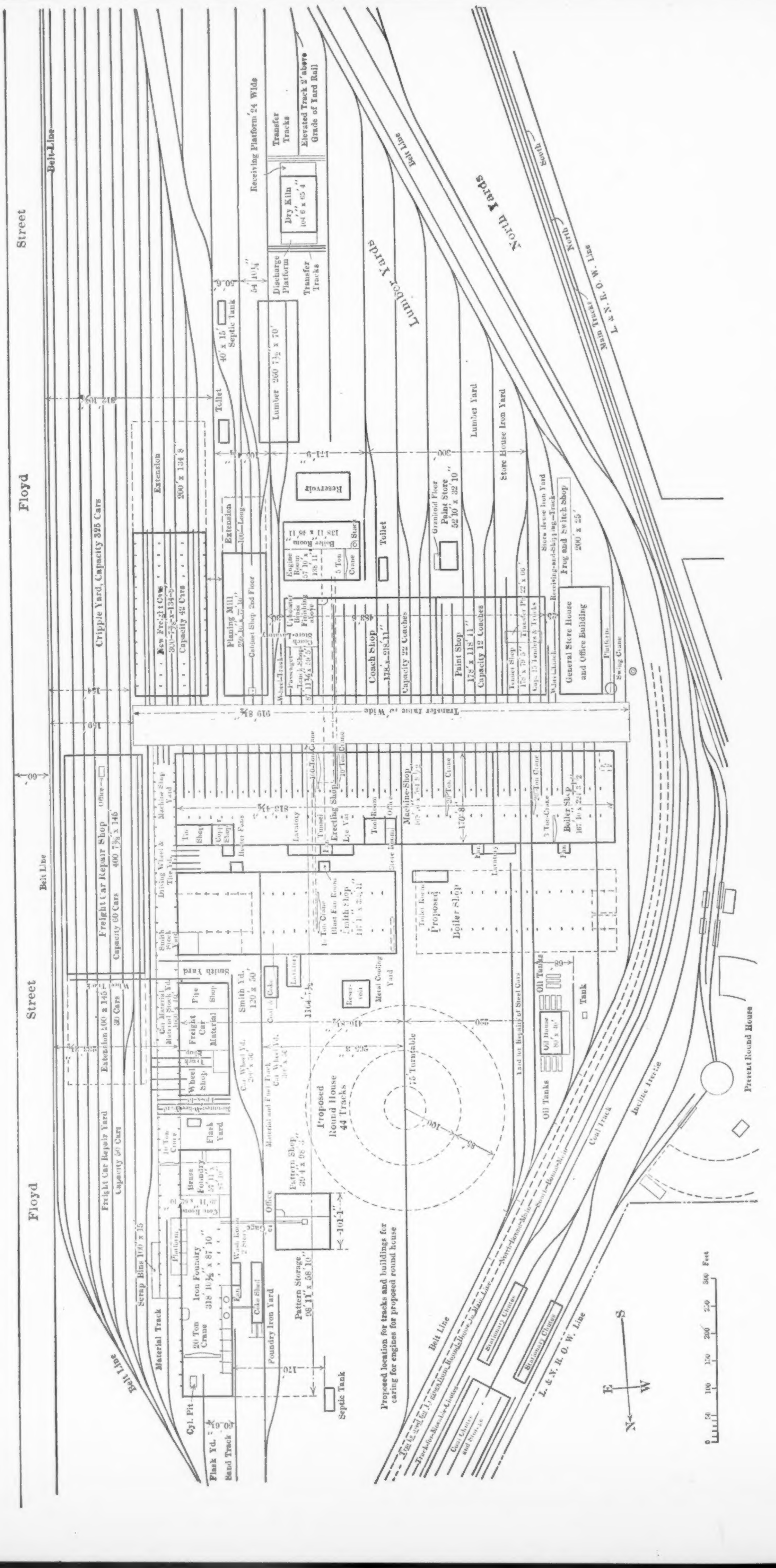
Probably none of the sheets that have been described are in their final form, but they have certain advantages over the inclusion of the various figures on a general performance sheet that are certainly strong arguments for a somewhat similar arrangement. They are obviously and, in fact, are entirely designed to meet the requirements of a service where men are regularly assigned to their engines, and would need modification were pooling in use. Certain features have, however, proved distinctly advantageous. The separation of the results above and below the average figure in the case of coal, and a rate or allowance for oil and repairs, has the result not only of enabling the good and poor performances to be detected at a glance, but exhibiting them in a way that appeals to the engine crews and all others concerned, and this has undoubtedly led to increased interest and improved results.

The separation of the coal, oil and repair sheets has made it possible to obtain the coal sheet, which is the one most promptly needed, within a sufficiently short time to make every one feel that the figures relate to recent and not historical events, and to call attention to an engine whose condition was such as to lead to increased consumption before the defect became serious enough to interfere with the handling of a train. The use of separate sheets has enabled the coal reports to be classified by runs, service and groups of engines, the repair reports by groups and headquarter statistics, while any report could be classified in any way thought desirable without affecting that method required for another, something that is quite important if comparisons are to be easy and effective as well as odious.

At first sight the clerical labor involved might appear formidable, but this is more apparent than real. The figures on the coal and oil sheets must all be obtained, and it is only those for the excess and decrease that are additional. The change consists more in the rearrangement than the number of the items except in the repair sheet, where the "Total to date" is an addition to the figures usually furnished. At the outside not over two men's time additional is required, compared to those for preparing a set of single performance sheets for 500 engines, and as the expenditures detailed would amount to $100,000 to $300,000 per month, it is evident that a saving of one-tenth of one per cent. would cover the additional cost. This is not material when the magnitude of the expenditures is considered, and in view of the fact that the performance sheets are practically our only detailed statements of the disbursement of coal, oil and running repairs, the writer believes that their form is worthy of careful study in order to render them as explicit and convincing as possible, and appeal to the individual to whom it is necessary finally to look for improvement and economy.

CONCRETE RAILROAD TIE.—In the April issue of the *Cement Age*, Mr. G. H. Kimball, chief engineer of the Chicago & Alton Railway, describes a concrete tie, several of which have been in service over four years with satisfactory results. The tie consists of two blocks of concrete each 3 ft. long, placed symmetrically under each rail so that the center of pressure and the center of figure of each section of the tie will coincide. These two blocks of concrete make one tie and are rigidly connected by being molded on the ends of a pair of 3-in. channels weighing three pounds per foot. The channels are back to back and spaced 2 ins. apart in the clear. The concrete blocks are 7 ins. thick and 9 ins. face, and the cross section is the same as that of a timber tie hewn or slabbed from a log about 11 ins. in diameter. It presents the appearance in the track of an ordinary tie with a piece 2 ft. 11ins. long cut out of the center. Hardwood blocks 3 ins. thick, 9 ins. wide and 18 ins. long, designed to cushion shocks, distribute pressure, support derailed trucks and serve as spiking blocks, are secured to the top of the concrete blocks. Each hardwood block is, of course, centered transversely to the line of the rail. Cast iron sockets that also serve to space and connect the channels are molded in place in the concrete, serve as an anchorage for holding down the hardwood blocks. These sockets receive suitable bolts, head down, so that when they are slipped to place and the holes through which they are introduced have been plugged they cannot be withdrawn. It is estmated that the ties weigh 436 lbs. apiece, and will cost about $1.18 each.

The saving of a few dollars in salary is often very expensive.



GENERAL PLAN OF SOUTH LOUISVILLE LOCOMOTIVE AND CAR SHOPS.—LOUISVILLE & NASHVILLE RAILROAD.

SOUTH LOUISVILLE SHOPS.

LOUISVILLE & NASHVILLE RAILROAD.

I.

GENERAL PLAN AND OPERATION.

The feature that impresses one most forcibly in studying the Louisville & Nashville Railroad shops at South Louisville is the careful provision for having the raw materials, which enter at the two ends of the plant (wood at one end and metal at the other), travel steadily toward their objective point, near the centre of the plant, which they reach in a finished state, requiring a minimum amount of handling and without doubling on their tracks. Not only does this idea predominate in the general arrangement of the shops, but, also as concerns the equipment and arrangement of each one of the shops. As the greater part of the manufacturing work for the entire system is done at this point and as considerable new equipment is built, in addition to the repair work, it is, of course, possible to develop this idea to a greater extent than if the shops were used entirely for repair work, although this arrangement could also be used to considerable advantage under such conditions.

As may be seen by referring to the general plan, the shops are arranged about an L-shaped system of transportation, consisting of a high speed transfer table, which travels over a distance of about 920 ft., or nearly the full width of the plant and an overhead high speed 10-ton travelling crane, extending over the stock yard for raw and semi-finished material, which is 1,000 ft. long and 40 ft. wide. Both the crane and the transfer table operate at a maximum speed of 1,000 ft. per minute. The metal working departments, including the machine and erecting shops, smith shop, wheel and axle shop and foundry, extend alongside of the travelling crane and the transfer table lies between the locomotive shop on one side and the freight car shop, planing mill, coach and tender shop and storehouse on the other.

At first sight the use of the transfer table in connection with the locomotive shop may be criticized. Ordinarily the engines are brought into the shop over this table. They can however, if necessary, be brought in from the north end of the plant over the track which enters near the middle of the locomotive shop, and by means of the 100-ton crane can be placed on any pit in the erecting shop. This department can, therefore, if necessary, get along without using the transfer table at all and not interfere greatly with its efficiency. It has been found that under normal conditions the transfer table is used 95 per cent. of the time by the car department and only 5 per cent. of the time by the locomotive department. As it seems to be practically impossible to handle coach work to advantage without the use of a transfer table, and as it is not in this instance necessary to the working of the locomotive department, but incidentally is a considerable convenience in handling the work of that department, the arrangement is to be commended. The transfer table could be put out of commission for several days without greatly interfering with the progress of the work through either the car or locomotive shops. The belt line around the plant and the arrangement of the tracks is such that the only points which would not be accessible would be a couple of tracks in the coach shop. Some difficulty would be experienced in delivering material from the planing mill to the freight car and coach shops, and in getting the passenger car trucks out of or into the coach shop, or in the quick delivery of material from the general storehouse to the various shops, although these difficulties would be overcome to a very great extent by the use of a large force of laborers. In one year's service the transfer table has not been disabled more than five hours. The use of the transfer table, and the fact, that switching may be done from either side of the plant, obviates the use of narrow gauge tracks and turntables. A feature which contributes to the safety of the men and facilitates the switching movements is that the tracks inside the plant are straight and the curves are largely confined to the belt line at the outer edge of the plant.

TRANSFER TABLE—LOCOMOTIVE SHOP AT THE LEFT.

A general study of the course of the various materials from the raw state to the finished product may make the advantages of the layout more apparent. In general the heavy metal parts are lifted and transported overhead, while the timber is transported on low cars with as little lifting as possible. All metal enters at the north end of the plant; part of it is unloaded at the foundry platform and transferred by the travelling crane to its proper place in the stock yard or to the various shops. The raw material for the foundries is delivered and stored at the west side of the building. The finished castings are taken out at the east side and are loaded from the platform directly on the cars, if they are intended for shipment to outside points, or if for storage or use in the plant are delivered to the proper place by the travelling crane and the transfer table. The wheels and axles are stored west of the wheel and truck shop. Stock from the blacksmith shop and foundries for use in the truck shop is stored underneath the travelling crane. The trucks, after they are set up, are transferred to the freight car shop by means of the travelling crane and transfer table. The double trolley on the travelling crane permits two freight car trucks to be handled at one time as well as conveying double loads of various kinds of material. Raw material for use in the smith shop is stored in the yard at the north side of the building. In some instances the cars are unloaded directly in the shop. Material manufactured in this shop for shipment to outside points is usually loaded on cars in the shop. Material for use in other parts of the plant is delivered by the cranes to the stock yard crane. Boiler plate, flues, bar steel, etc., are stored to the north of the boiler shop building. The division between the boiler and the machine and erecting shop consists of a low brick wall over which material can readily be transferred by the travelling cranes. Nine-tenths of the metal which passes beyond the transfer table on the car side is used in the freight car shop, which is just across the transfer table from the end of the stock yard crane. Locomotives coming into the shop are taken on the transfer table at the west end. The tenders are either taken into the tender shop or are stored on tracks at the rear of this shop.

Lumber enters the plant at the south end. The sills are stored to the east of the dry kiln. The lumber yard south

of the coach shop has a capacity for ten million feet of lumber. The lumber is transported on cars 2 ft. high. That which goes through the dry kiln is loaded on special cars and these cars after passing through the kiln are run onto the yard cars and transported to the lumber shed or to the planing mill and cabinet shop, as may be desired. All timber enters the planing mill at the south end and is delivered at the north end in a finished state and is transferred to either the freight car shops or to the coach shop by the transfer table. The coaches and tenders are brought into the shop over the transfer table but in case of an emergency can be brought in over the tracks at the south side of these shops. Freight cars needing repairs are stored in the cripple yard of 325 cars capacity. They are repaired either in the freight car repair shop, which has a capacity for 60 cars, or in the repair yard, which has a capacity for about 80 cars. The freight car repair shop is so located that finished material for use on the cars is carried, on an average, only 60 ft.

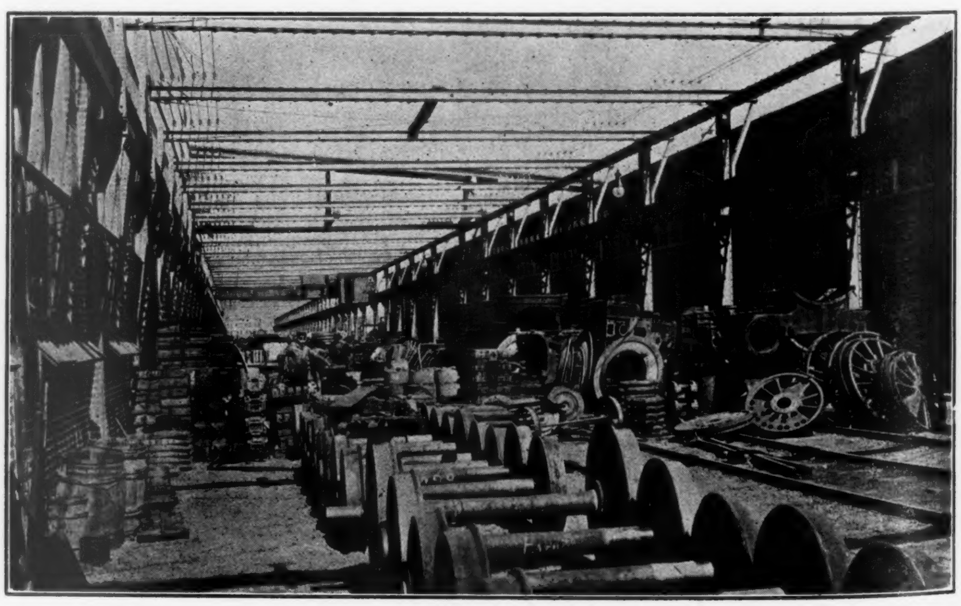
TRAVELLING CRANE AND STORAGE YARDS—VIEW FROM ABOVE.

The shops have been in operation for considerably less than a year, and at the present time repair about 30 engines and build two new ones each month. The car department repairs about 100 freight cars and builds about 15 new 80,000-lb. capacity gondola cars per day. In the coach shop about 30 coaches are repaired and about two new ones built each month. The shops are so arranged that by the extension of the buildings and rearrangement of the departments their capacity can be increased about one-third. The dotted lines on the plan show the extensions which may readily be made to the various buildings. If a new boiler shop should be required it can be located as shown, and the space occupied by the present one can be added to the erecting and machine shops. Provision is also made for the erection of a 44-stall roundhouse, as shown.

The power house is located near the planing mill in order to use the shavings for fuel. As the amount of power required by the planing mill is comparatively large the centre of gravity of the power distribution would probably lie somewhere near the center of the transfer table and the power plant is thus not as far from the center of distribution as might appear.

The general storehouse for the entire Louisville & Nashville System is located near the west end of the transfer table. This storehouse receives and delivers all store supplies to and from the shop, by the use of the transfer table and small cars. It is also located to permit of easy switching from the belt line to either side of the storehouse. This enables the store department to receive all shipments of material from the outside in carload lots and redistribute it in like manner. A large oil station is provided, directly west of the blacksmith shop. It has capacity for sixty days' supply of oil for the Louisville & Nashville System, north of Nashville. A supply of 30,000 gals. of crude oil is provided, as this fuel is used largely in the smith shop and brass foundry.

The plant occupies a tract of 55 acres, 12½ of which are under roof. The buildings are arranged and designed to secure north light and avoid direct sunlight in the buildings, this being an important consideration in the latitude of Kentucky. They are also arranged to take advantage of the southern breezes, an important feature during the summer months. The plant was laid out and the equipment selected and arranged by Mr. Theodore Curtis, superintendent of machinery. The buildings were designed and their construction supervised by the engineering department of which Mr. W. H. Courtenay is chief engineer, under the direct charge of Mr. J. Werness, principal assistant engineer.



TRAVELLING CRANE AND STORAGE YARD.

(To be continued.)

FREIGHT CAR CONSTRUCTION AND ITS COMMERCIAL ASPECT.

BY L. H. TURNER.

To the man who has been more or less closely allied with car construction and maintenance for over a third of a century the subject presents many interesting and oftentimes amusing features. The car builder of thirty-five years ago made but little use of the technical assistant, and, in fact, but few technical men were employed in the work. Testing machines and laboratories were scarcely known, and the trained eye of the mechanic was the gauge of strength and utility. The commercial side of the question did not receive the consideration it does to-day when the greatest effort is made to obtain the lowest possible light weight with the maximum carrying capacity. The introduction of malleable castings and pressed steel shapes in modern cars has worked wonders in adding to the earning capacity and reducing the total weight of train load, and while a wonderful improvement has been made in the general construction of freight car equipment, we have been inexcusably blind to some points that should have been seen years ago.

The modern steel car, the highest type of freight-carrying vehicle, has been built and probably will continue to be by some, equipped with the M. C. B. twin spring draft gear with a capacity of 38,000 lbs., and then placed behind locomotives with a tractive power ranging from 40,000 to 50,000 lbs. This is one of the results of not giving consideration to what the car is to be subjected to after it leaves the hands of the builder, or of leaving the design to some one not familiar with service conditions, either of which is disastrous to the car owner.

We overlooked another matter when we specified the twin spring gear, viz.: that steel center sills do not have the shock-absorbing capacity of the old wooden car, and that when the weight of the impact exceeds 38,000 lbs. something must take care of the balance. The coupler usually provides the means. If the coupler is strong and the sills somewhat light, then the sills bulge and a few similar jolts put the cars on the shop track.

It is no exaggeration to say that the weak point of the all-steel car or the steel underframe car is the center sills, or what might be more nearly correct, that the designer's weak point was his failure to recognize the fact that while the steel sills were amply strong to stand all pulling tests, they lacked the elasticity to stand the strain placed upon them while being handled in gravity yards or under other conditions where the treatment is beyond what is ordinarily expected of a car.

This liability to damage can and should be corrected by the application of friction draft gears and buffer blocks. We believe that the M. C. B. Association erred in not fostering and encouraging the use of buffer blocks either in the solid casting or the spring design, which is far more preferable, as they not only distribute the shock over more of the end of the car, but about double the spring capacity. Friction gears are a necessity and are productive of a great saving, and when used in connection with a spring buffer on steel cars will save and earn more than any other device that can be purchased for the same amount of money.

This fact was quite clearly shown by some observations recently taken in which one lot of steel cars equipped with one pattern of friction draft gear showed a coupler breakage of 18.5 per cent. of all on the cars so equipped. Another friction gear showed 6.9 per cent., while a mixture of wood and steel cars with twin spring attachments and in some cases spring buffers had a percentage of 4.7 per cent. It should be stated that the spring buffers were all on steel cars, indicating that buffer springs and wood are very good mediums for absorbing shocks.

While it must be conceded that the friction gears are of much help, they still do not give the same assistance as is rendered by the wooden car in absorbing the shock, and this seems to prove that something more is needed, and we know of nothing better than the spring buffer.

We have also been blind, generally speaking, to the importance of a proper center plate and side bearing. We seem to have forgotten that the same company that purchases the car has to pay the cost of hauling it, and we have built up a largely increased percentage of train resistance due to center plates of improper design, truck and body bolsters so weak as to place the greatest part of the load upon the side bearings, which of necessity must bind the truck upon the track, resulting in increased train resistance, worn flanges, worn rails, increased expenses and decreased earnings, all of which might be largely eliminated by the use of some of the devices upon the market which will to a great degree remove the friction between the car body and truck, and while it is deplorable to have to admit it, it must be confessed, meritorious appliances are often turned down because they are not the product of our own brain or at the direction of some officer who is always haunted by the phantom of "First Cost." The head of the car department of to-day must roam outside of department lines and be as zealous in considering the ultimate results and the wisdom in adding to the first cost of the car in order that he may reduce the cost of maintenance and get more miles per year out of it, due to the lesser number of trips it makes to the repair tracks, as he is in following time-honored traditions and gratifying his personal hobbies.

The office of the head of the mechanical department in this progressive age presents as many opportunities for working out great economies as any other employed in railroad operation, and fortunate is the road who has a mechanical head who can look above the mechanical details and recognize the fact that the car represents the earning power of the company, and is not simply a vehicle capable of sustaining a given load. The most necessary adjunct to the clear-headed mechanical man is the superior officer or purchasing power who has confidence in his ability and honesty to decide as to what type of construction will in the end prove to be the most economical and bring about the best results to the stockholders.

It is gratifying to observe that the policy of buying cars on a question of price alone, regardless of whether it would require six or ten pounds of power per ton to move them or whether they would be serviceable for five or fifteen years, is being relegated with many others that have proven to be unwise.

In confirmation of the wisdom of giving the closest attention to car construction in the way of using the lightest materials of the greatest strength in order that the revenue load may be increased to the highest per cent. of the total weight of the train, also that all pains be taken to reduce the rolling friction to the least possible draft upon the locomotive, a few figures may well be presented showing the comparative earning value of the modern steel car of 100,000 lbs. capacity costing $1,200 and the up-to-date locomotive of 40,000 lbs. tractive power costing $16,000. The car loaded to its capacity with the usual 10 per cent. excess at $0.006 per ton mile, earns $33 for each 100-mile haul. The locomotive with the liberal allowance of 500 tons of revenue freight per train earns $300 for the same distance. The cost of the car is but 7.5 per cent. of that of the locomotive. and while the cost of maintenance of the car is less than one cent per car mile, the locomotive requires at least six cents per engine mile. Placing the life of both at fifteen years, you will have expended on the locomotive for first cost and maintenance (assuming it runs 100 miles per day) $48,850, and it will have earned $1,642,500, or 3362.3 per cent. on the capitalization, while the car will have cost $2,295, and will have earned $36,135, or 1574.5 per cent. on the capital invested.

Owing to traffic and other conditions, cars only average twenty miles per day, and this might be regarded as a suggestion to the transportation departments that the most fruitful source of increased earnings is by increased mileage of freight cars. The figures given above plainly show that if by a reduction of terminal and shop track delays the car can be made to make forty miles a day, that its earnings on the

capital invested will nearly equal that of the locomotive, which will further strengthen the argument that it is money well invested in bringing the car up to the same standard of efficiency and economical operation as the locomotive, and that the same pains be taken to keep it moving.

New trade conditions make it necessary that the car of to-day shall fill more requirements than those of the past. It must be capable of carrying a greater variety of commodities, and thus avoid deadhead mileage. It must be constructed so as to be loaded with the least possible cost to the shipper of pipe, structural steel, lumber, etc. This is particularly true of the twin hopper steel gondola, which must be made available for pig metal, billets, and similar material, and the hopper door fastenings must be of a design which will prevent absolutely any loading working out and causing damage to its own or other trains. When the necessities already recognized and those which will be seen are complied with, the freight car will take the place it deserves, viz.: on a basis of equality with the locomotive as an earning factor.

STANDARDIZING LOCOMOTIVE EQUIPMENT.

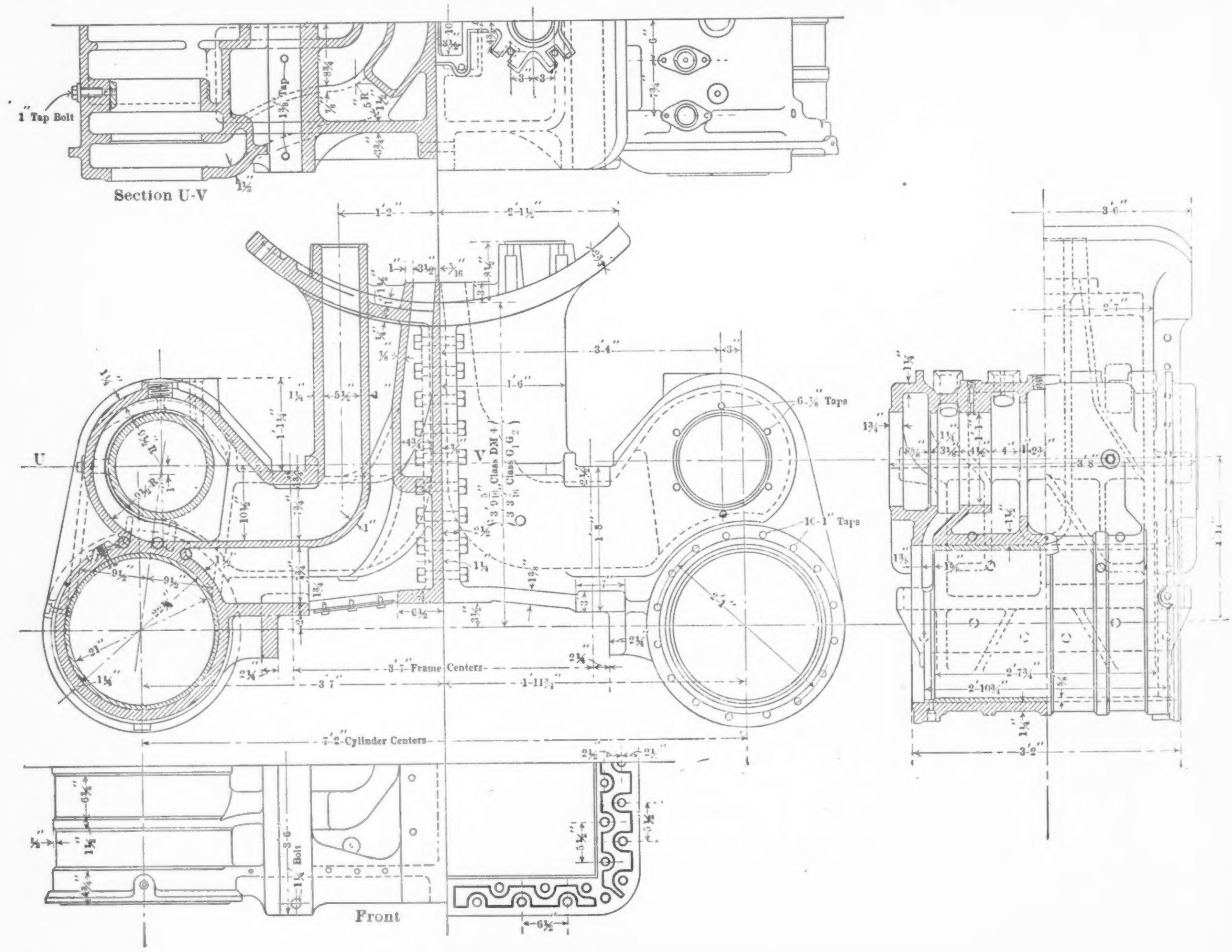
CANADIAN PACIFIC RAILWAY.

III.

In the previous articles, on pages 126 and 161, the very broad application of the standard locomotive parts recently adopted by the Canadian Pacific Railway for use on the three types of standard engines, viz., Pacific, ten-wheel and consolidation, was pointed out and a general description, with dimensions, of the typical classes of each type was given. In this and later articles will be shown a number of the more interesting details which are common to the standard engines as well as, in many cases, to a large number of locomotives not considered as standard. In considering these it should be remembered, as was stated in the first article, that it was advisable, as far as possible without affecting their value for future work, to retain many old parts which had been satisfactory and could with small change be made to serve on several different classes.

Cylinders.—All of the standard engines have 21 by 28-in. simple cylinders with piston valves, and a design has been adopted which is interchangeable with classes M4, D10 and D11 and differs from the cylinders used on the classes G1 and G2 only in the height and radius of the saddle. This design is shown in the illustration.

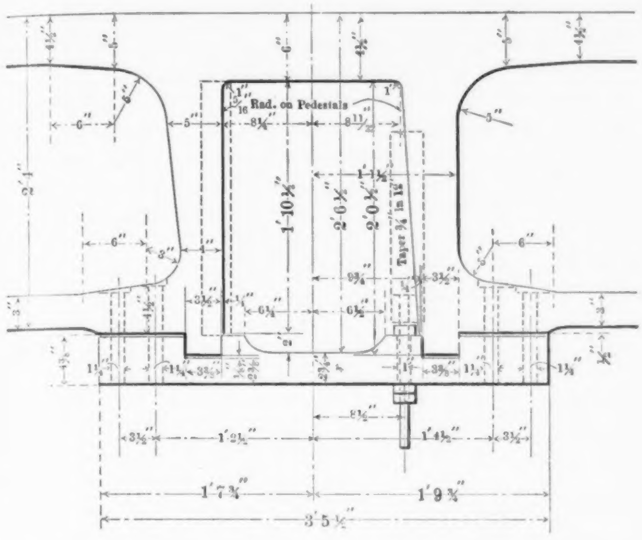
Piston valves with inside admission are used and the steam is brought to the valve chamber through a direct passage. It is exhausted at the ends through passages with liberal area and easy bends, which are separated from the live steam passage by a wide air chamber at all points. This feature is of special importance where superheated steam is used. The valve chamber is somewhat longer than the cylinder in order to allow an almost direct steam port, the extension at either end being taken up by the exhaust passage. The casting is made for use with a ⅝-in. cylinder bushing and has 1¼-in. cylinder walls. The arrangement is for a double bar frame spanning the cylinder, the top rail being fastened by four 1⅜-in. vertical screw bolts and the bottom rail by six 1½-in. horizontal bolts through the lower flange and two 1¼-in bolts at the ends. Both rails have deep shoulders at both ends of the cylinders and are further secured by keys.



STANDARD CYLINDERS—CANADIAN PACIFIC RAILWAY.

Frame Details.—The principal features of the frames which have been standardized are the pedestals, shoes and wedges

and pedestal binder. Since the cylinders, as far as the frame fits are concerned, are in duplicate on the five classes, it follows that this portion of all frames is the same and com-



STANDARD PEDESTAL AND BINDER—CANADIAN PACIFIC RAILWAY.

prises two rails, the upper being 4½ by 5 ins. and the lower 4½ by 6 ins. in section. The main frames, of cast steel or wrought iron, are 4½ ins. wide and have a depth of the upper rail varying from 4½ ins. between pedestals to 6 ins. over pedestals.

The illustration herewith shows the standard pedestal for the main drivers with its binder. This differs from the other pedestals only in width, being ½ in. wider on either side of the center, or an inch total. The strap binder is finished for ⅛-in. draw, and is held by two bolts at either end passing through the frame. The simple design of wedge adjustment is clearly shown in the illustration.

Driving Boxes.—A special design of cast-steel driving box has been adopted in two sizes, the 9½ by 12 for main drivers and 9 by 12 for others. These boxes are used on 143 engines outside of the standard classes. The illustration shows the larger box, the other being similar except for dimensions in connection with the smaller journals and narrow pedestals. It will be noticed that the box is a simple straightforward design, and has a brass of 1⅞ ins. in thickness at the crown, held in place by two ¾-in. brass pins in the center. Two longitudinal oil grooves ½ in. square in section are milled for nearly the full length of the brass at about the 45-deg. line on either side and are connected by diagonal grooves, of a smaller section, from either end. Two ⅜-in. oil holes on either side extend from these grooves to the top of the box. A ⅜-in. bronze liner is riveted at the bottom of the shoe and wedge fit, and a ¼-in. babbit plate cast onto the box gives a bearing against the hub. The cellar is of cast iron and has an opening covered with an iron plate on an inclined portion of its inner side, which allows the packing to be renewed and inspected without taking down the cellar. The other details of the box are clearly shown in the illustration.

(To be continued.)

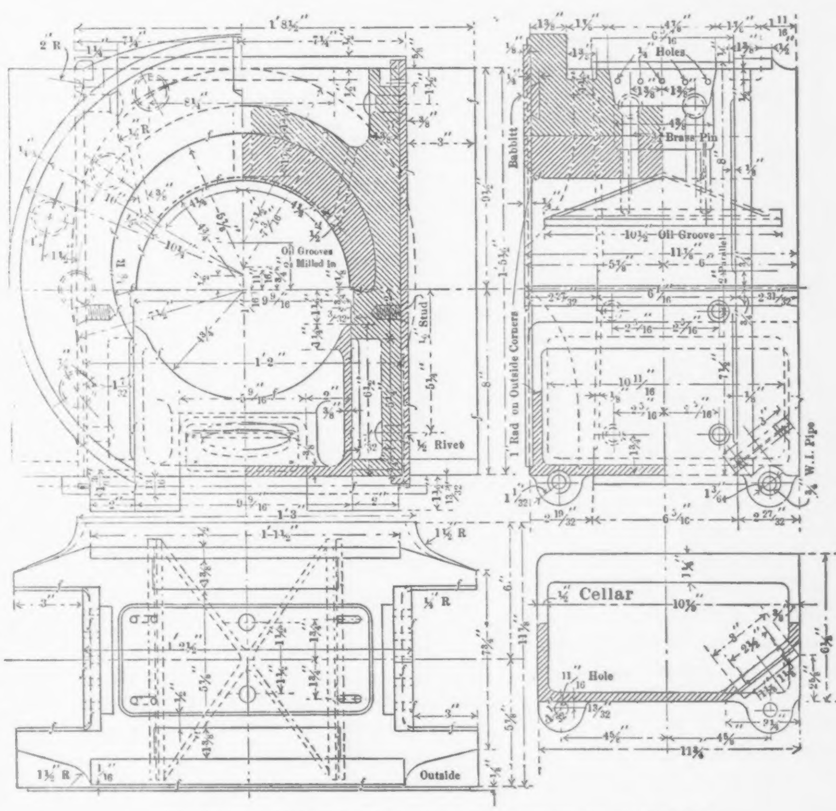
KAISERIN AUGUSTE VICTORIA.—This is the name of a new Hamburg-American ocean liner which is 700 ft. long, 78 ft. beam, and has eight decks above the water line. Her displacement is 43,000 tons, and a crew of 550 officers and men will be carried.

IMPROVING THE MACHINE SHOP OUTPUT.

BY C. J. MORRISON.

To increase the output of the machine shop the builders make heavier machine tools, the shop experts design special jigs and tools and the steel makers turn out steel to cut at speeds unheard of a few years ago, but little attention is paid to the source of all output—the power. What good is the heavy machine, the special jig and the high-speed steel if there is a deficiency in power? Of what practical value is a machine capable of turning out a piece of work in thirty minutes if it is only supplied with power enough to do the work in an hour? Most of the direct-driven machines are supplied with sufficient power to drive the cut, but fall down on the feed. There are also a number of widely advertised machines supplied with motors of sufficient power and transmissions which can carry only one-third or one-half the power of the motor.

It is the machines which run in the groups, however, that are the worst sufferers. We find machine after machine supplied with such narrow pulleys for belts that they can only be run at a small fraction of their rated capacity, and even then suffer many serious delays through belt failures. This happens even in shops where the belt receives the best possible care and only first quality belting is used. Not only are the belts themselves unable to transmit the power required, but the excessive tension at which they must be run heats



STANDARD DRIVING BOX—CANADIAN PACIFIC RAILWAY.

the journals, and in some cases has actually sprung the shafts. A machine built the last month of 1905 requires 12 to 15 h.p., and is equipped with a belt which, when strained to its utmost capacity, can transmit only 6.4 h.p. Even at this horse power the belt is strained beyond the point where it can give service free from failures.

A very great saving may be made by equipping the machines with pulleys of the proper width and by giving proper attention to the care of the belts. The saving is threefold; first, time saved by cutting out loss of time due to belt failures; second, in the actual cost of belt maintenance; and, third, in the increased output due to running the machines to their full capacity. In a shop using 1,500 belts a belt foreman was ap-

pointed, a belt room installed, and a regular system of caring for belts established. The result the first year was almost startling. Failures were reduced from 375 per month, with an average delay of thirty minutes each, and often delaying 10 to 20 men, to 44 per month, with an average delay of five minutes each, and never delaying over two or three men. By a failure is meant any belt trouble which delays a workman. The expenses were reduced 90 per cent., and showed an actual money saving sufficient to buy and install the finest wheel lathe on the market. At the same time, partly due to the belts and partly to other causes, the output of the shop was increased over 100 per cent. This was accomplished in spite of the fact that many of the machines had pulleys of inadequate width. Had all the pulleys been the proper size the failures could have been reduced to about 15 per month, the expenses reduced 95 per cent., and the output increased 10 to 15 per cent. more.

These points are well worth the consideration of machine tool builders and shop superintendents. A machine deficient in belt power should not be purchased at any price. Neither should belts be allowed to take care of themslves. One hears in every shop: "Belts are cheap. Tear up the belts and turn out the work." This is a mistake. Belts are expensive. Poor belts cost more than good ones. Properly caring for the belts increases the output and saves money.

A machine should not be accepted which has a weak or poorly designed feed arrangement. There is no advantage in taking a heavy cut and an infinitesimal feed. A number of the latest machines have had the entire feed arrangement rebuilt within a month after being put to work on account of breaking or slipping under a heavy feed. This not only caused a direct money loss, but the high-priced machines were piling up surcharges which made their future work expensive. In fact, in some cases it would have been cheaper to have performed the work at a slower speed on the old machines which had been discarded as out of date.

THE ST. LOUIS LOCOMOTIVE TESTS—PENNSYLVANIA RAILROAD.

By G. R. Henderson.

The report of locomotive tests at the Louisiana Purchase Exposition, prepared by the Pennsylvania Railroad System, is very comprehensive and contains a great amount of valuable matter that has never before been presented to the public, and it is with some hesitation that I attempt to make any resumé of this elaborate work.

At the end of the book are found a half dozen pages entitled "Summary of Conclusions," and these give in a nutshell the general results of the tests. There are some further points, however, which are of great interest to motive power men, and while it must be distinctly understood that there is no attempt being made to include even a large portion of the vital points which are exploited in this report, yet it seems as if it would be interesting to lay particular stress upon a few of the subjects which have heretofore excited considerable comment and conjecture as to their actual value in connection with locomotive performance.

* * * * *

Amount of Coal Fired.—In the first place, the amount of coal that was fired on these engines is of interest in connection with the enlarged grate areas and heating surface of modern boilers, and the complaints made at different times that it would be difficult to obtain a fireman whose capacity was equal to getting the full amount of work out of the firebox. On page 122 we find the statement that the work of firing imposed at all times a severe task on the fireman, and that it would be realized more fully when it is considered that he often had to fire continuously for three hours and maintain approximately the maximum steam pressure, not having the benefits of the short periods of rest afforded in actual service by descending grades and sidetracks. It is further stated that in some of the tests there were fired 6,700 pounds of coal per hour, and, notwithstanding the fact that two firemen were provided, when hot weather came the fireman on one occasion fainted, and it was necessary to provide fans in order to introduce cooling air, which in road service is obtained by the motion of the engine. In the last month of the test the work became so heavy that a third fireman was necesssary.

From this statement it appears that the limit of one fireman was practically reached by the consumption of fuel upon the engines on this plant, and it will be interesting to note the amount of coal burned per square foot of grate area per hour due to this quantity of fuel.

We give below a table showing approximately the general results of these tests, from which it appears that, as stated before, the maximum coal consumption, or really the maximum amount of coal fired, was 6,700 lbs. per hour. As this was with an engine having quite a large grate, that is, 50 sq. ft., the rate of combustion per square foot of grate area was only 134 lbs. per hour, and we have, in the case of engine 734, a somewhat higher rate, viz., 140 lbs. per square foot of grate per hour, the draught in this case being 5.9 ins. of water in the smokebox, whereas with engine 3000 the draught was 8.9 ins.

	Coal per Hour		Per Sq. Ft. of Grate		Grate	Max.
Engine No.	Min.	Max.	Min.	Max.	Area.	Draught.
628	1000	3500	34	121	29	3.7"
2512	700	3000	21	91	33	3.5"
734	1100	4700	33	140	34	5.9"
535	900	5800	18	120	48	6.7"
1499	1100	4200	22	86	50	4.7"
585	1000	2800	20	56	50	3.7"
3000	1300	6700	26	134	50	8.9"
929	1100	4300	19	74	58	3.7"

We all know that this rate of combustion and this amount of draught are frequently exceeded in ordinary practice, as it has been shown at different times, not only in road service, but also on other testing plants, that the rate of coal combustion may amount to 200 lbs. per square foot of grate per hour. We also know that the draught gauge will frequently show 12 or 13 ins., which would correspond to a rate of combustion in the neighborhood of 200 lbs. The formula which is used to indicate the ratio or proportion between the coal consumed per square foot of grate surface per hour and the draught in inches of water in the smoke box, approximates .05, or the draught equals 1/20 the number of pounds consumed per square foot of grate per hour; that is, a rate of combustion of 200 lbs. would require 10 ins. of draught in the smoke box. This is not very far from what we also find in stationary practice, where a rate of combustion of 20 lbs. per square foot or grate requires very nearly 1 in. of draught at base of the chimney. It is evident, therefore, that none of the locomotives which were run in these tests were forced to the ultimate limit of their firebox capacity. There are reasons for this, and very good ones; one, owing to the fact that if the full power of the locomotive was obtained at slow speeds, there was continual slipping of the wheels and a very irregular action of the brakes, due to rapid fluctuations in the water pressure which controlled the Alden brakes. On the other hand, at high speeds the vibration of the engine was so great that it was impracticable to reach, in some cases, the limit of the boiler. These results would seem to show that there is now actually a need for a good locomotive stoker which can handle quantities of fuel far in excess of the capacity of the ordinary fireman, and that the demand for such a stoker is liable to increase rather than decrease with the large-sized boilers that are now used. If, however, it is considered advisable to still fire these locomotives by hand, it is quite evident that we cannot get the full power out of the locomotive which would be possible if we could supply the box with larger quantities of fuel.

* * * * *

The Quality of the Smoke Box Gases is something that gives us rather a surprise, as it is a popular opinion that locomotives are not only wasteful in fuel, but also give very

imperfect results from the combustion of the fuel. We find, however, that the percentage of CO_2 was very nearly as good as will be found in first-class power plants and better than will be found in a great many. While in different cases the amounts were something like this: 9.8 to 13.0, 10.6 to 13.3, 6.9 to 12.9, 12.0 to 14.0, the averages varied between 10 and 13 per cent. of CO_2 for the different locomotives tested, the actual averages being represented by the following figures: 10, 11, 11, 12, 12, 12, 12, 12.5 and 13. These results can certainly not be considered as at all unfavorable for the analyses of smokebox gases of a locomotive, and show us that many of the conclusions regarding the imperfect combustion of fuel in the locomotive are erroneous.

In connection with the percentage of CO_2 the efficiency of the boiler is a natural sequence. Of course we know that there are many cases when large quantities of fuel are rejected in an unburned condition from the smoke stack, but there are many times when the ordinary service conditions are quite conducive to economy. For instance, the following table will show the efficiency of the boiler at minimum and maximum coal rates, also the average of the different runs:

At Maximum Coal Rate.	At Minimum Coal Rate.	Average Efficiency.
45	79	60
42	71	55
60	78	68
54	74	65
51	78	65
44	78	63
39	63	60
47	75	63

The average efficiency of the boiler in these tests will therefore be found in most cases above 60 per cent. In only two cases did the average fall below this figure. With stationary boilers in first-class order and regulation settings with every convenience to obtain good results from the use of fuel at comparatively low rates of combustion, the efficiency will not often run over 70 per cent., and here, again, we have the second surprise, in that, even considering the great steam capacity of the locomotive boiler, its efficiency is only about 10 per cent. less than that of the average first-class stationary boiler.

* * * * *

THE MACHINE EFFICIENCY is a third surprise, at least it will be to those who have held the view that at high speeds the locomotive absorbs nearly all the energy which it produces; that is, that it could haul very little besides its own weight, due to the internal friction of the engine. Of course it must be borne in mind that in the case of these tests there were no head winds to be encountered; there were no grades to surmount, but the rolling friction and the friction of the parts of the interior mechanism of the engine were present probably just as largely as they would be under conditions of road service. The machine efficiencies from the general tests, roughly grouped, are about as follows:

At. Min. Draw-bar Pull.	At Max. Draw-bar Pull.	Max. Efficiency.	Aver. Efficiency.
77	77	82	78
90	78	94	88
92	79	94	86
81	88	90	85
89	75	89	80
85	79	88	80
94	83	94	88
93	68	94	88

These efficiencies are all certainly very favorable to the machinery of the locomotive, as they are all practically 80 per cent. or over on the average, and in some cases have reached as high as 94 per cent. Engine 3000 was the only one which they were able to run at 320 revolutions per minute or 75 miles an hour, and at this speed the efficiency was 78 per cent.. It is noted in the comments that the loss of power between the cylinder and the draw-bar is greatly affected by the character of the lubricant, and it appeared from the tests that the substitution of grease for oil upon axles and crank pins increases the machine friction from 75 to 100 per cent.

When we consider the combined efficiency of the boiler and the machine, we are prepared for the comments which are made, as follows:

"It is a fact of more than ordinary significance that a steam locomotive is capable of delivering a horse power at the draw-bar upon the consumption of but a trifle more than 2 lbs. of coal per hour. This fact gives the locomotive high rank as a steam power plant."

We think that this testimony of the committee in their conclusions is one of great interest and importance, and that it will stand as a monument to the much maligned locomotive as a steam generator and prime mover.

* * * * * *

THE QUALITY OF THE STEAM furnished by the boiler is also much better than has been ordinarily expected. Of course, it must be borne in mind that the locomotive was standing on the test plant, and it is possible and probable that the foaming or priming was not as great as would be the case when running over a railroad track more or less rough. It is rather surprising, however, that the quality of the steam, as shown in the dome, varied between 94 and 100 per cent.; that is, that there was less than 6 per cent. moisture in the worst cases, and the average showed that the moisture was not over 1½ per cent. When the steam advanced into the steam pipe, the super-heat, due to wire drawing, reduced this amount 1 per cent., so that the average quality of steam in the branch pipe was about 99½ per cent. of dry steam. This is certainly a very interesting result and one that was hardly expected.

* * * * *

THE EVAPORATION PER POUND OF COAL was very satisfactory. It is true that a good quality of coal was used, it having been uniformly obtained from the Scalp Level Mines, near Johnstown, Pa., and had about 76 per cent. fixed carbon and 7 per cent. of ash. The uniformity of the results is very apparent by a diagram published in the report in which the evaporation of water per pound of coal varied about as follows, for different rates of combustion, per square foot of heating surface per hour:

Rate of Combustion.	Minimum Evaporation.	Max. Evaporation.
.5	10.5	12.0
1.0	8.5	10.0
1.5	7.0	8.5
2.0	6.0	7.5

It will be noticed that for all the tests of the different locomotives the variation between the evaporative rate was only 1½ lbs., at rates of combustion from ½ to 2 lbs. of coal per square foot of heating surface per hour, and we can assume that for fuel of this quality the evaporative efficiency is almost sure to fall within these limits.

With the information above given, we can construct another table showing the pounds of water per square foot of fire heating surface per hour, due to the maximum evaporation and the rates of combustion above selected:

Pounds of Steam per Sq. Ft. of Heating Surface per Hour.

Rate of Combustion.	Maximum Evaporation.
.5	6.
1.0	10.
1.5	12.8
2.0	15.

While the evaporative efficiency is generally greatest when the rate of combustion is least, as indicated by the previous table, yet it is seen that under the conditions which existed in these tests it was possible to obtain 15 lbs. of steam per square foot of heating surface per hour, this heating surface being measured on the fire side of the tubes, and if we consider a horse power to be represented by 34½ lbs. of steam from and at 212 deg., we find that a horse power was developed at the maximum rate of combustion from a little over 2 sq. ft. As, however, the engines in many cases used less steam per indicated horse power per hour than this amount, there is absolutely no difficulty in obtaining an engine horse power from 2 sq. ft. of heating surface. It has been customary to consider that foreign locomotives running without diaphragms or obstructions in the smoke box are much

more efficient in the use of fuel than American locomotives, in which the obstructions placed in the smoke box necessitate a higher back pressure and a greater smoke box vacuum. It is interesting to notice, however, that the two engines which had no diaphragm in the smoke box (Nos. 628 and 2512) actually gave the lowest evaporation per pound of coal.

Assuming that 34½ lbs. of water represents a horse power as stated above, the different engines delivered the following proportions of a horse power per square foot of heating surface: .36, .35, .28, .29, .26, .41, .35, .47. These figures are slightly less than the value which Prof. Goss found on his Purdue testing plant, where he found that 1 sq. ft. of heating surface was equivalent to .43 h.p. In this case, however, Prof. Goss considered that 28 lbs. of steam was sufficient for a locomotive horse power, which, if followed in the present case, would give figures very closely agreeing with Prof. Goss' assumption.

The maximum indicated horse powers given by the locomotives under test vary from 816 to 1641. The freight engines gave horse powers varying between 1041 and 1258, so that the passenger engines show the greatest variation, the largest horse power being given by engine 3000, which was the Cole compound Atlantic type. These horse powers were obtained by indicator diagrams from the cylinder, and in connection with the steam generated and the horse power delivered, it is interesting to determine the amount of steam used per indicated horse power per hour. We find that the simple engines gave a minimum steam consumption on the average of 23.7 and a maximum of 29.0. These figures are better ,as a rule, than the allowance of 28 lbs. above quoted from Prof. Goss. It is also interesting to discover that the most economical cut-off for the simple engines, at the various speeds at which the engines were run, was found to be 30 per cent. nominal; that is, when the valve cut off the steam at 30 per cent. apparent cut-off, no matter what speed, the engine was being run at the best economy.

The compound engines gave a minimum water rate of 18.6, and a maximum of 27.0. It was here found that the most economical cut-off ranged from 35 to 50 per cent. on the high-pressure cylinder, the ratio between low and high pressure cylinders in these engines varying from 2.3 to 2.8. These water rates are not at all abnormal, but are what have frequently been found in actual road tests on similar engines, and indicate very concisely what may be expected under service conditions with simple and compound locomotives.

* * * * *

TRACTIVE FORCE.—It is to be regretted that large tractive forces were not developed on the test plant. The reason for this was that owing to the fluctuations of water pressure used for controlling the brakes, it was impossible to work the engines at slow speeds and long cut-offs, as there was constant danger of stalling the brakes and slipping the wheels, and it was therefore found impossible to construct directly for the different locomotives diagrams showing the maximum draw-bar pull at all speeds. An attempt was made, however, to show what might be expected under the conditions in which these engines operated, but they cannot be taken as an index of what would be obtained in actual service. We must also bear in mind that the limitations of the fireman prevented the use of fuel to an extent which would be possible under heavy draught conditions, and that these two facts mitigated against obtaining the maximum tractive force at slow speed.

As an illustration of this we will consider briefly the tractive force which could ordinarily be expected and what was actually obtained. In determining the maximum tractive effort which the engines would be capable of giving, the formula

$$\text{Tractive force} = \frac{.8pd^2s}{D} \text{ was used,}$$

where p = the boiler pressure; d, the diameter of the cylinder; D, the diameter of the drivers; and s, the stroke of the piston; the dimensions being in inches and the pressure in pounds. For compound engines the proper allowance was made for the ratio of cylinders. It was found that in no case did the actual draw-bar pull, as measured by the dynamometer, anywhere reach the tractive force as determined by the formula, but it must be noticed at the same time that the point at cut-off was very much less than it should be in order to obtain the full tractive effort. The formula above given ordinarily considers that the reverse lever is carried in the corner notch, with a cut-off something between 80 and 90 per cent., and bearing this in mind the figures given below will help us to reach an understanding as to why the full draw-bar effort was not realized:

Calculated Trac. Force.	Max. Aver. Trac. Force.	Per cent. cut-off.
39,773	22,078	37.
33,616	24,522	41.
31,838	24,539	57.
63,612	31,240	51.
16,700	8,615	35.
19,245	12,815	53.
13,789	9,016	45.
20,590	12,780	54.

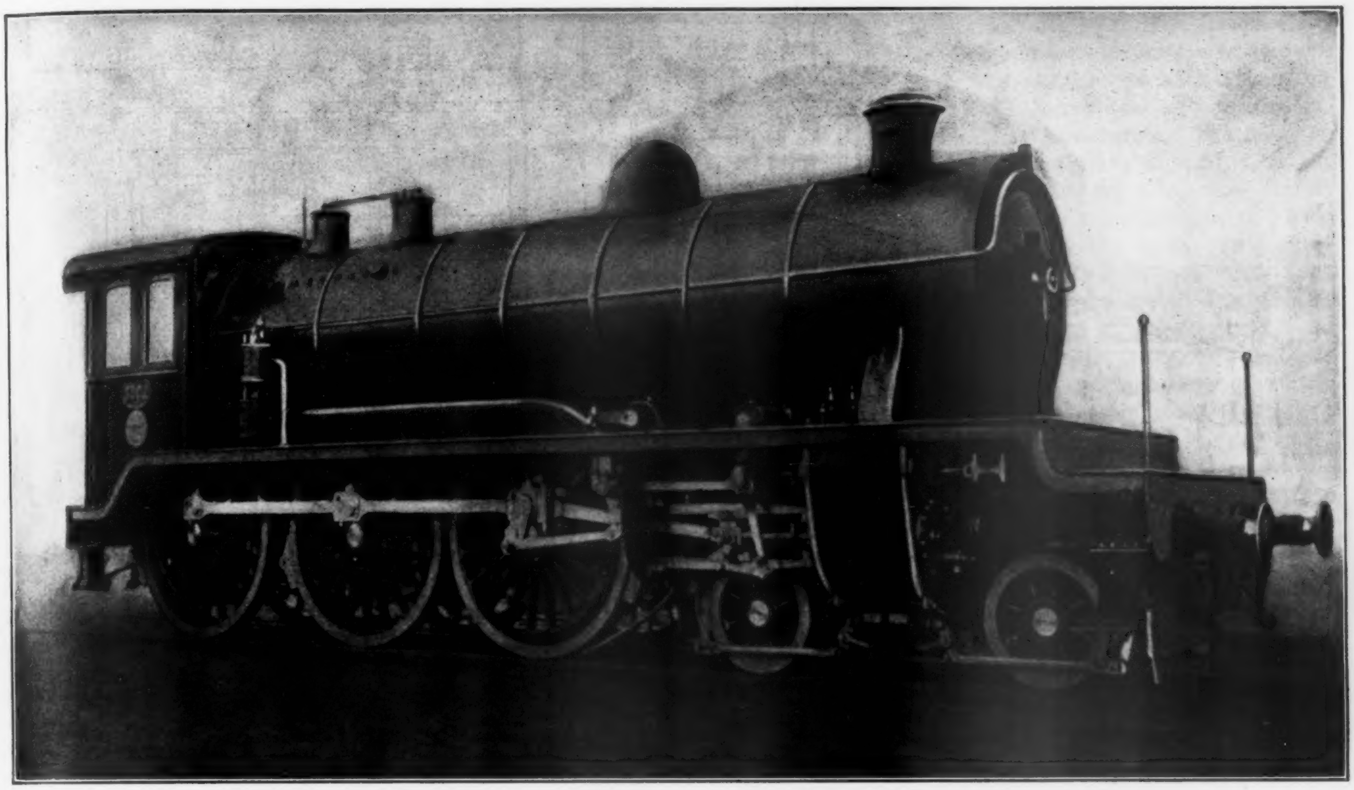
In the table the first two engines listed are single expansion locomotives, while the last six are compounds, the cut-off given as of the high-pressure cylinder. From these points of cut-off it is not only evident that the full draw-bar pull could not be expected, but it is also evident that the full rate of fuel combustion was not obtained, especially at the slow speeds. The figures given, therefore, as representing the draw-bar pull, do not by any means show what could possibly be hauled upon the road, and while they correspond with many cases that would occur in actual service, yet they do not represent the work of the engine hauling a full train rating up a heavy grade at a slow speed. These points should all be borne in mind in connection with the study of the results of these tests. and it must not be concluded that greater powers or higher speeds could not be obtained in actual service than were obtained during these tests, owing to the causes which prevented full service conditions being followed as explained above.

TRANSCONTINENTAL SPEED RECORD.—Mr. E. H. Harriman, president of the Union and Southern Pacific railroads, traveled from Oakland, Cal., to New York City, a distance of 3,255 miles, in 71 hours 27 minutes, arriving on May 8. This wonderful trip was made by special train as far as Buffalo, from which the Empire State Express was used. The following table gives the distances and times between different points on the trip:

Left Oakland, Cal., 7:33 P. M., May 5.
Left Sparks, Nev., 243 miles, 6:47 A. M., May 6.
Left Green River, Wyo., 714 miles, 10:15 P. M., May 6.
Left Omaha, Neb., 824 miles, 2:58 P. M., May 7.
Left Chicago, 490 miles, 1:25 A. M., May 8.
Left Buffalo, 536 miles, 1:00 P. M., May 8.
Arrived New York, 440 miles, 10:00 P. M., May 8.

CIRCULATION IN LOCOMOTIVE BOILERS.—It is generally supposed that the circulation in a locomotive boiler proceeds along the bottom of the barrel from the front end down the firebox front and up the sides and back of the firebox. The author, two or three years ago, fitted a number of vanes in a boiler with spindles passing through lightly packed glands to the outside, with indicators to show the direction of the flow of water. Observations showed that the circulation was generally as stated above, but a little alteration of the firing had the effect of materially changing the direction of the currents and even of completely reversing them.—*Mr. G. J. Churchward, before the Institution of Mechanical Engineers.*

NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION.—This association, which now includes almost sixty establishments, held its spring convention at Atlantic City, May 1 and 2. The purchaser's price for lathes, planers and shapers was advanced 5 per cent., and of upright drills from 5 to 10 per cent. A paper on the apprenticeship system was presented by Mr. E. P. Bullard, and the question of a minimum profit and cost system was discussed at length.



FOUR-CYLINDER BALANCED SIMPLE PASSENGER LOCOMOTIVE.—BELGIUM STATE RAILWAYS.

SIMPLE FOUR-CYLINDER PASSENGER LOCOMOTIVE WITH SUPERHEATER.

BELGIUM STATE RAILWAYS.

One of the most complete and extensive exhibits of locomotives shown at the exhibition held at Liege last year was that of the Belgium State Railways, which included 13 different types or classes of simple and compound locomotives in several arrangements of wheels and cylinders, and using both saturated and superheated steam. One of the most interesting engines in this exhibit, because of its comparatively new and novel features, was a heavy 10-wheel passenger locomotive, having four simple cylinders arranged on the balanced principle and equipped with the latest design of Schmidt fire tube superheater.

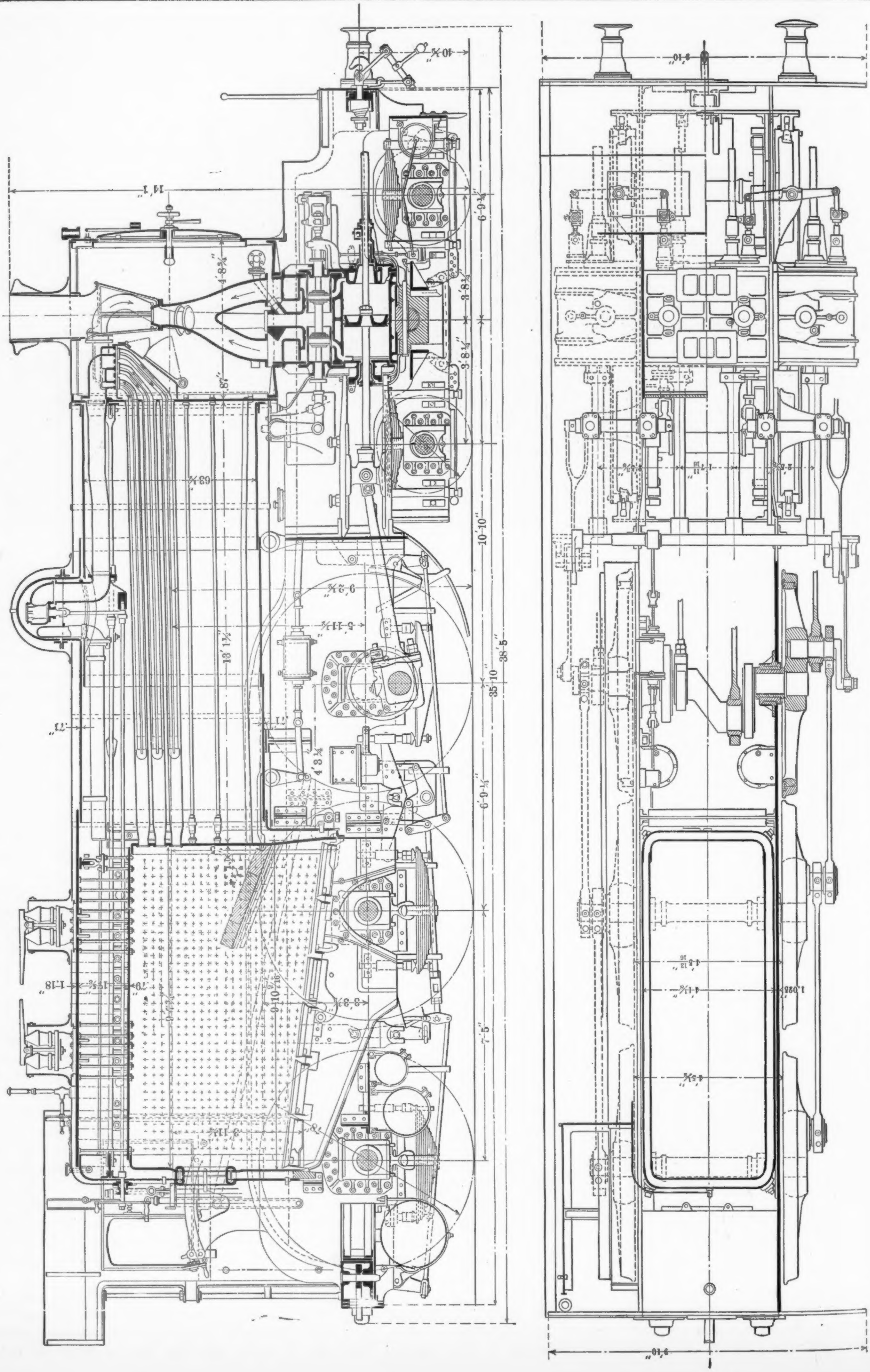
This locomotive, which is illustrated herewith, was constructed by the Societe Anonyme la Meuse, of Schenien, from the drawings made by Mr. Flamme, general inspector, under the direction of Mr. Bertrand, director of the State Railways. It forms one of a group of engines which have been constructed largely for experimental purposes; the others included a four-cylinder simple engine without superheat and four-cylinder balanced compound engines both with and without superheat.

As can be seen from the illustrations, the four equal cylinders are arranged in a line across the center of the four-wheel truck in the same relative position as that used on the Baldwin four-cylinder balanced compound locomotive. All the cylinders are connected to the front pair of drivers, which has a built-up crank axle. The connection is such that the two cylinders on the same side of the engine are at 180 deg. with each other and at 90 deg. with the corresponding cylinders on the opposite side. Inasmuch as all moving parts in both cylinders and the main rods are exact duplicates, it follows that this connection gives an absolutely perfect balance on each side of the engine.

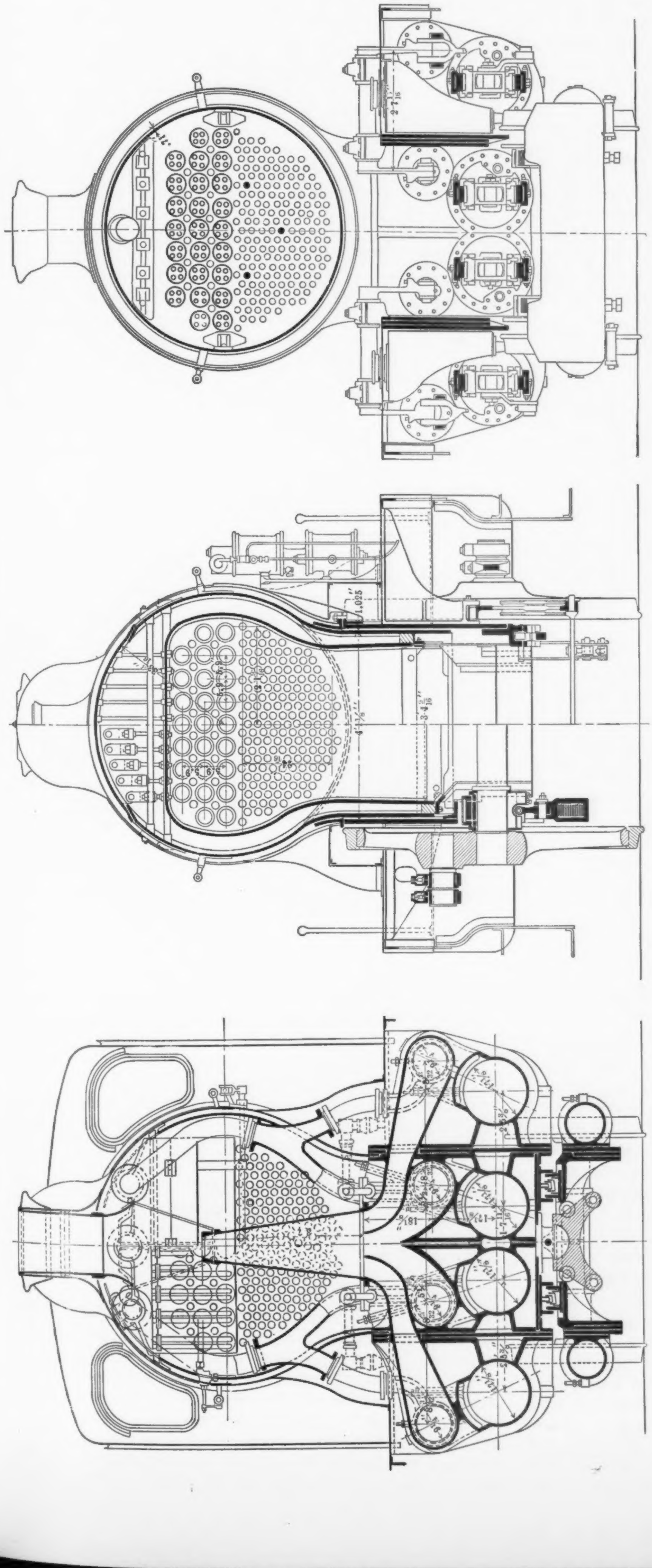
The operation of each cylinder is controlled by a separate piston valve, 7⅞ ins. in diameter, with inside admission; the two valves on each side of the engine being operated by a single Walschaert valve gear. The use of inside admission valves with Walschaert gear ordinarily requires the reversing of the connections of the radius bar and valve rod to the combination lever, in addition to the revolving of the return crank, so that its connection is 180 deg. from its usual position. In this case, however, since the inside piston is connected at 180 deg. with the outside, the valve gear was connected from the outside crank pin and crosshead in the same manner as if it was to operate an outside admission valve on the outer cylinder. This movement is then transferred to the inner valve through a rocker arm, and gives it the correct position for an inside admission valve on that cylinder. This arrangement giving a satisfactory movement to the inside valve, it was necessary to simply connect the outside valve so that it would have an opposite movement. This was done by extending the inner valve rod through the front head and connecting it to the lever which extends across the frame and operates the outer valve through a valve rod extending through its front head. These connections are clearly shown in the diagrammatical view given herewith.

Since each of the four cylinders are operated independently it is necessary to have four separate steam passages to and from the valve chambers. This has been done in a very simple manner, which shows clearly in the cross section through the cylinders, by bringing the regular steam pipes from the superheater head to about half their usual length, where a joint to a Y-shaped steam pipe is made. The two branches of this connect to the different valve chambers. The outer one passes outside the front end and connects through a short pipe with ground joints to the side of the valve chamber. The inner one extends down and connects in the usual manner inside the front end. The cored steam passages inside the cylinder casting for both the exhaust and the admission have been carefully worked out, and in no case does a single wall separate the two passages. This feature is of particular importance in engines using superheated steam, and is one which can be more easily solved when an inside admission valve is used. The four exhaust passages connect to a single exhaust pipe having two broad sections at the base, which join into a single pipe, as is shown in the longitudinal section of the locomotive. This pipe has a 5-in. nozzle.

The boiler, which is similar to American practice in general arrangement, although not in construction, is of the narrow firebox type; the grate area being large as compared with general European practice, although not as large as that



SECTIONAL ELEVATION AND PLAN OF FOUR-CYLINDER BALANCED SIMPLE LOCOMOTIVE.—BELGIUM STATE RAILWAYS.



CROSS-SECTIONS OF FOUR-CYLINDER BALANCED SIMPLE LOCOMOTIVE.—BELGIUM STATE RAILWAYS.

used on some former locomotives in Belgium. This particular locomotive was designed to burn briquetted coal, and hence does not require an excessively large grate. The flues, of which there are 180 of brass, 2 ins. in diameter, and 25 5-in. iron tubes, which enclose the superheating pipes, are 13 ft. 1½ ins. long. This gives a heating surface of less than 1,500 sq. ft. in the tubes, but the firebox, because of the large grate and its depth, gives over 180 sq. ft., or more than 10 per cent., of the total heating surface. The crown sheet is flat and supported by crown stays, and there are also horizontal stays between the outside firebox sheets above the crown sheet. There are four stays between the tube sheets, which are fitted with turn buckles for adjustment. The method of fastening the front tube sheet to the boiler shell is interesting. The flange of this sheet is turned outwards, and to it is fastened the smokebox sheets. The fastening between the boiler shell, which is of smaller diameter than the smokebox, and the tube sheet is by means of a circular angle placed outside the barrel and riveted to both. The front tube sheet, in addition to the four stays to the back sheet previously mentioned, is also further stayed by bars running from a horizontal angle above the line of the flues for the full length of the boiler to a similar connection at the back head. These bars also have turn buckles for adjustment.

The superheater is of the Schmidt fire tube type, and in each of the 25 5-in. tubes there are two loops of iron pipe extending from the steam header, which, all told, give a superheating surface of over 419 sq, ft. The passage of the gases through these flues is controlled by a damper in the front end, which is closed when the locomotive is not using steam. The superheater is capable of giving a temperature of from 570 to 660 deg. F. to the steam, the temperature being varied by the amount that the damper is opened. A thermometer gives the engineer exact information as to the temperature of the steam.

The frames, like all European equipment, are of the plate design, being 1 1-32 ins. thick, and over 30 ins. in depth over the driving boxes, and nearly that at the point just back of the cylinders, which is the narrowest section. The two frames are tied together by vertical cross plates at several different points, and are placed as far apart at the rear as the driving wheels would permit, so as to allow the firebox, which extends down inside the frames, to be as wide as possible.

Cast steel driving boxes are used with filled brass journals. The spring rigging, which is all underhung, shows

clearly in the longitudinal section, and it will be seen that much care has been taken to keep the proper alignment and easy movement of all of this rigging. The springs are carried from a connection to the bottom of the driving box, and are located directly below the box, the equalizers being between the wheels.

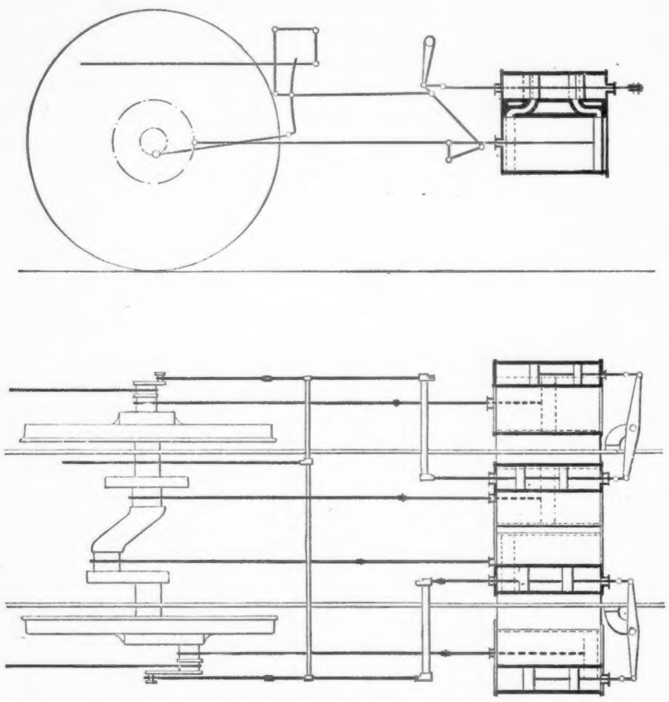


DIAGRAM OF VALVE GEAR.—FOUR-CYLINDER BALANCED SIMPLE LOCOMOTIVE.

The engineer stands on the left-hand side of the cab, as is becoming the practice abroad on locomotives with large boilers. A type of steam reverse gear is used, the cylinder for reversing being located on the inside of the frame just back of the reverse shaft. A combination of lever and screw control of reversing gear is used.

We are indebted to Mr. Flamme, inspector of the Belgium State Railways, for the drawings shown herewith.

The general dimensions, weights and ratios are as follows:

SIMPLE FOUR-CYLINDER LOCOMOTIVE—BELGIUM STATE RAILWAYS.

GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Service	Passenger
Fuel	Briquetts
Tractive effort	31,500 lbs.
Weight in working order	179,300 lbs.
Weight on drivers	115,500 lbs.
Weight on leading truck	63,800 lbs.
Wheel base, driving	14 ft. 2 ins.
Wheel base, total	38 ft. 8½ ins.
RATIOS.	
Weight on drivers ÷ tractive effort	3.66
Total weight ÷ tractive effort	5.7
Tractive effort x diam. drivers ÷ heating surface	147
Total heating surface ÷ grate area	51.7
Firebox heating surface ÷ tube heating surface	12.2%
Weight on drivers ÷ total heating surface	68.9
Total weight ÷ total heating surface	107.
Volume both cylinders	12.8 cu. ft.
Total heating surface ÷ vol. cylinders	131.
Grate area ÷ vol. cylinders	2.53
CYLINDERS.	
Number	4
Kind	Simple
Diameter and stroke	17⅛ x 24
VALVES.	
Kind	Piston
Diameter	7⅞ ins.
WHEELS.	
Driving, diameter over tires	78 ins.
Driving journals, main, diameter and length	7⅞ x 10⅝ ins.
Driving journals, others, diameter and length	7⅞ x 10⅝ ins.
Engine truck wheels, diameter	35 7-16 ins.
BOILER.	
Style	St. top.
Working pressure	205 lbs.
Inside diameter of first ring	65 ins.
Firebox, length and width	118.67 x 40.55 ins.
Tubes, number and outside diameter	25-5, 180-2 in.
Tubes, length	13 ft. 1½ ins.
Heating surface, tubes	1494.84 sq. ft.
Heating surface, firebox	181.70 sq. ft.
Heating surface, total	1676.54 sq. ft.
Superheater heating surface	419.27 sq. ft.
Grate area	32.4 sq. ft.
Smokestack, height above rail	14 ft. 7 ins.
Centre of boiler above rail	9 ft. 2¼ ins.
TENDER.	
Water capacity	4,400 gals.
Coal capacity	13,230 lbs.

LOCOMOTIVE SHOP MANAGEMENT.

By A. W. Wheatley.

Shop management, to a railroad company, is a subject of great importance, and one which has a considerable bearing on the cost of locomotive repairs. The main repair shop is in reality the manufacturing plant of a railroad. On this account it should be watched and operated precisely the same as a private manufacturing plant.

The private manufacturer is at a great advantage in this respect, inasmuch as he is familiar with the prices of his competitors, and, judging by the values of commodities when placed on the market, adjusts himself to meet competition. With the railroads it is different, because the officers or men operating their plants are not familiar with the cost of manufacture at the shops of their competitors, and comparisons are unfortunately made by the number of engines turned out, and on this account railroads suffer in the following manner: The shop superintendent is frequently informed that a certain shop on a neighboring road is turning out, possibly, 40 engines per month, and he is made to feel that he should exceed that number. Possibly he may have a number of engines in the shop needing very heavy repairs, and in order to satisfy his superiors and not damage his reputation he will reach out and shop engines needing but very light repairs. Frequently engines which could make more mileage are shopped on this account. These engines will be run through in order to obtain a respectable output in numbers, because the efficiency of the plant is judged, not by the cost of repairs, but by the number of engines turned out. The average shop superintendent is at a loss to know what the engines cost the other railroads—which, of course, should be the true basis of comparison.

The railroads are operated to make money, and the output of the shop should be regulated purely from a financial standpoint. To assist in this respect, we must first have a uniform classification of repairs, and the writer offers the following:

No. 1. New firebox, with general repairs to machinery.

No. 2. Side sheets or heavy boiler work with general repairs to machinery.

No. 3. General repairs to machinery, with all flues removed.

No. 4. General repairs to machinery, part flues removed.

No. 5. General repairs to machinery only.

With such a classification adopted generally we can ascertain what it is costing other roads to make repairs, and the efficiency of a shop will then be judged, not by the number of engines turned out, but by the cost of repairs. When the shop superintendent is put up against figures, he will, in turn, put his subordinates up against them, with the result that even the rank and file will know what it costs to do the work.

Because of this the writer feels that in a day work shop the erecting shop should be divided into gangs; each gang covering not more than six pits. Mechanics should be given the engines after leaving the stripping pits and complete the repairs, except for the driver brake, steam pipe and truck work, which should be handled by special gangs. Each month a statement should be published and distributed to all concerned showing the cost of repairs to each engine, by departments; also the cost of material. The gang foreman making the best showing should rank first; the next best, second; and so on down. Those below the aver-

age should be investigated and asked to explain, and coached along, if necessary. Such a system tends to bring about splendid results, both in the saving of labor and material. It makes men familiar with the cost of material used, which to-day in a good many railroad shops is almost unknown. With this system in operation, you are making managers out of your foremen, as well as the machinists themselves. The average man is ambitious and dislikes to be outdone by his fellow-man. If certain engines cost too much, the machinists in turn will have to explain, and if there is no inclination shown to do better, you are justified in dropping them from the service. On this account the above plan is preferred to the "piece gang" system. By this is meant the practice of having certain men do certain work; as, for instance, one gang doing all the frame and cylinder work on all the engines in the shop; another gang doing shoes, wedges and driving boxes. With this system we make specialists instead of managers; it has a tendency to destroy the interest the men should take in their work. Mechanics, as a rule, like to complete repairs to a locomotive, and watch with interest the results when the engine is placed in service. With the "piece gang" system, if the cost of repairs is high, it is difficult to ascertain which is the slow or expensive gang.

In making repairs, the engines after being stripped should be thoroughly inspected, and a schedule should then be made out. The important parts should be scheduled, and every one concerned should receive a copy of it. A daily report should be made showing whether the engines are being repaired on schedule time, and, if late, the cause of delay should be given. Such a report enables the shop superintendent to keep in touch with his entire plant. If delays are caused on account of waiting for material, he should take the necessary action to have it hurried. A common cause of delay in most shops is waiting for tires and other heavy parts, which is very expensive material to carry in stock. It helps considerably in this respect to have monthly reports sent to the shop superintendent showing the physical condition of the power in service. These reports serve to notify him as to what will be required, when an engine is shopped, in the way of tires and wheel centers, also firebox material. These reports should be scrutinized closely and the store department notified. This will help the store department very materially, and will prevent many aggravating delays.

In this connection the mechanical and store departments must get closer together and work more harmoniously; friction between these departments is expensive for the railroad company. On account of not working together, the storekeeper is frequently compelled to carry a very heavy stock in order to protect himself, for in many cases he has undoubtedly been unjustly blamed for not carrying material in stock.

Shop deliveries should be made by messengers, and on no account should mechanics be allowed to frequent the store room. Such a system will require the installation of a private telephone exchange, which no up-to-date shop should be without.

Each gang should have its own complement of tools, such as wrenches, sledges, punches, spring pullers, and pinch and slipping bars. On the machine side there should be a demonstrator, and considerable care must be taken in selecting the proper man for this position. He should be a leader in every respect. Demonstrations should be made and time taken and careful record made of it. These demonstrations will prove which is the best tool to use, and when this has been done, it should be adopted as a standard for the entire road. Machine tools should be kept in the tool room, and all dressing and grinding should be done there.

Care should be taken in locating machines to see that the "lost motion," or carrying of material back and forth is reduced to a minimum; for instance, the machines doing driving box work should be so located that the boxes will pass from one machine directly to another alongside, and not be trucked to another part of the shop. This also applies to rod work and piston work, etc.

The boiler shop should be provided with its own tool room, with a first-class mechanic in charge of tool maintenance. Care should be taken in the location of machines, in relation to the flange fire. Work in this department, on account of its nature, is specialized. The shop should be well provided with jib cranes and hoists. Flue shops should be so arranged that flues, after leaving the cleaner, are placed on cars instead of on the floor or rack, and moved to machines and furnaces in sets. With such an arrangement flues can be cleaned and safe-ended and swaged at a cost of between two and three cents apiece.

The blacksmith shop should be well equipped with up-to-date forging machines, with industrial tracks to each machine to enable unfinished material to be taken from the car to the furnace and machine, then back to the car, and eliminate the picking up process now so common in railroad shops. Fires should all be numbered—this to simplify distribution of work.

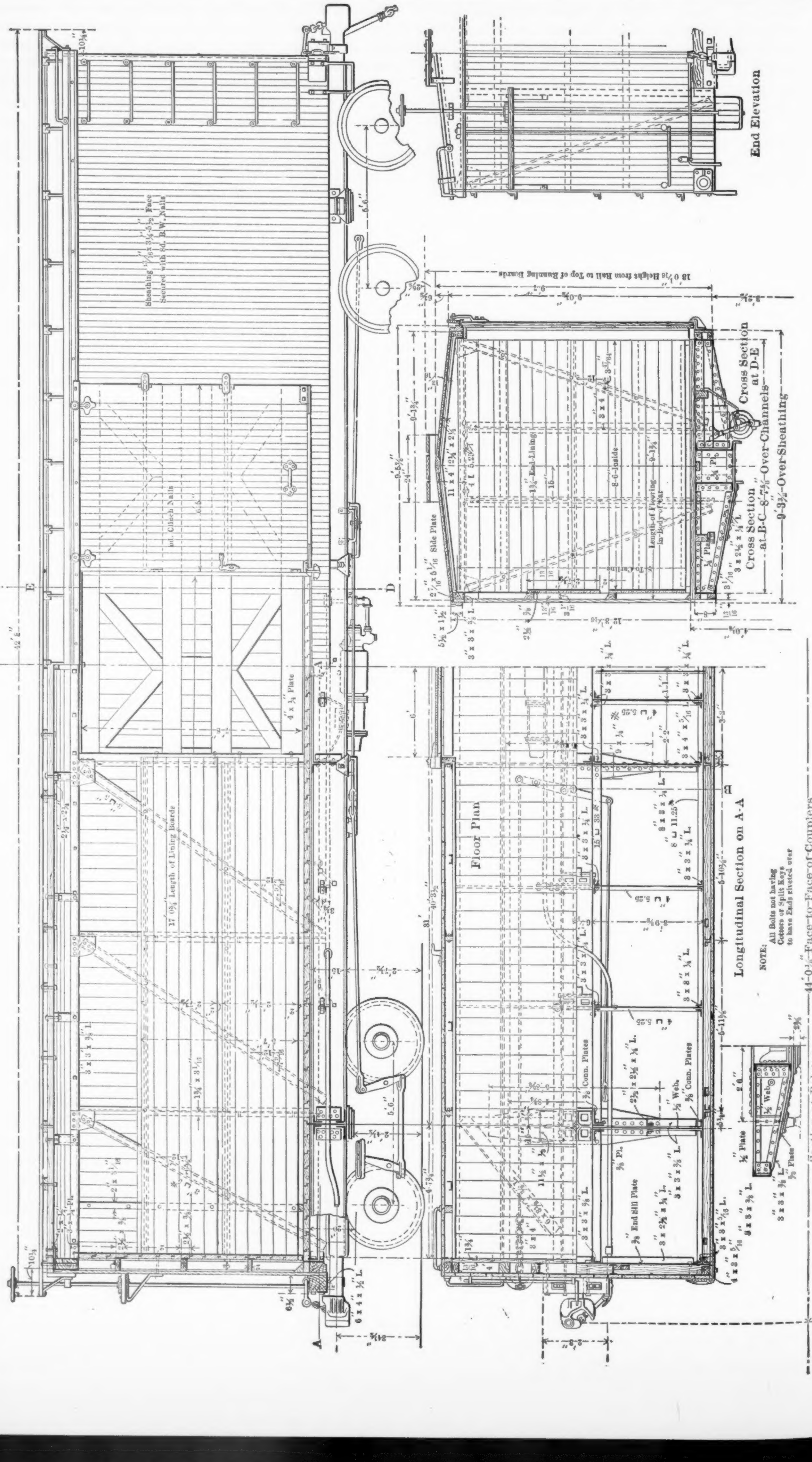
Meetings of all foremen should be held every two weeks, and all should be made to feel at liberty to express themselves. The superintendent of shops should spend a considerable part of his time in the shop and be very careful to demonstrate occasionally—this in order to show that he understands his business. In these days nothing will command respect quicker than confidence in the ability of the leader. In addition he must be fair, upright and cheerful. Cheerfulness is contagious, and spreads with great rapidity, and it inspires confidence.

In the past much attention has been given to shop design and, unfortunately, very little to shop organization. No matter how well a shop is designed and equipped, the efficiency of the plant will depend solely upon the man in charge of operations.

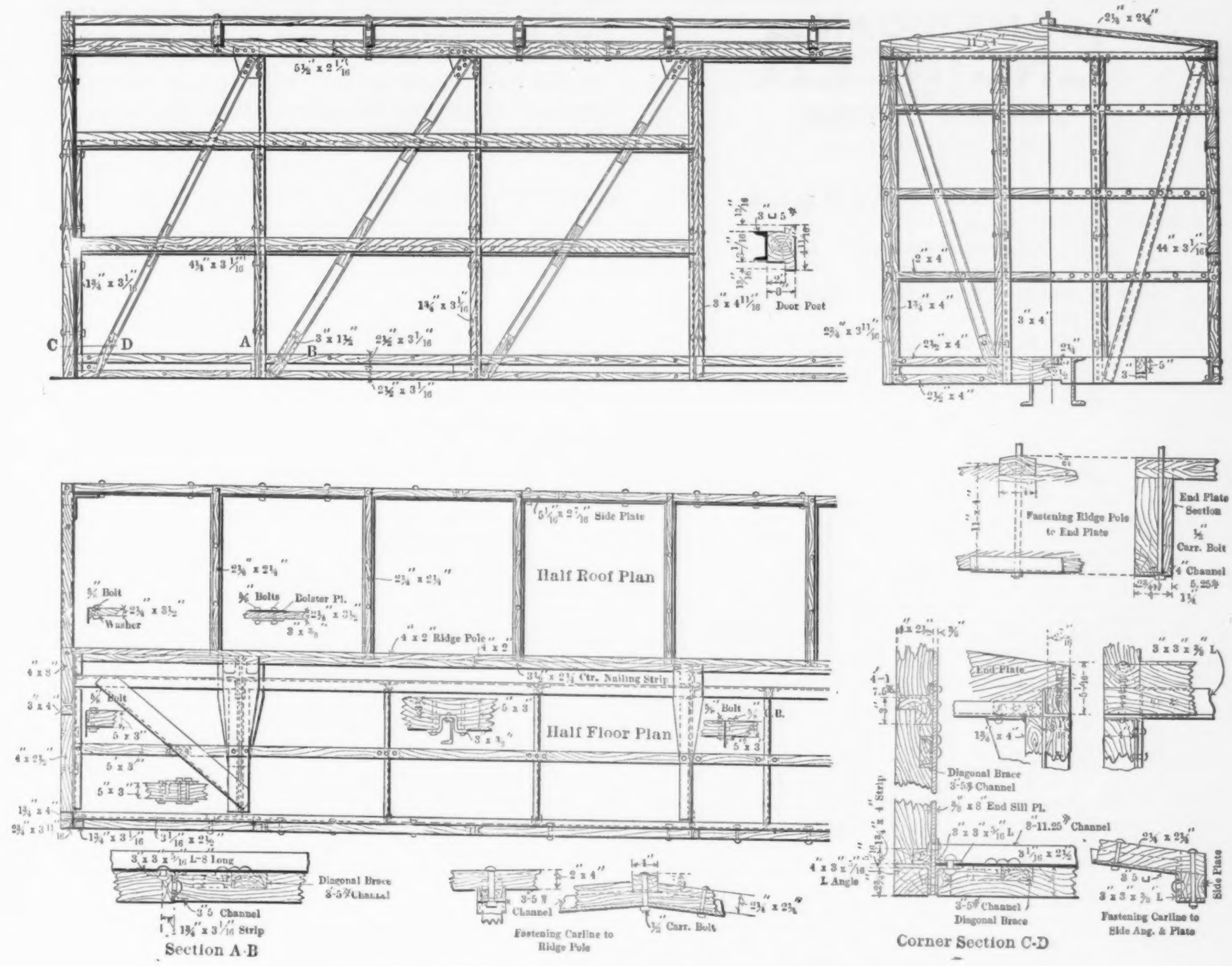
LOCOMOTIVE VS. STATIONARY PLANT.—The locomotive is ordinarily considered a crude and wasteful type of heat engine, unsusceptible, by reason of the rugged character of its service, of the refinements of its stationary and marine contemporaries; a machine highly developed if you will, for a special purpose, but in which efficiency as a heat engine has been sacrificed to the necessities of its nomadic and strenuous existence. This popular idea of the locomotive will be rudely shaken by the volume before us, which declares that "It is a fact of more than ordinary significance that a steam locomotive is capable of delivering a horse power at the draw-bar upon a consumption of but a trifle more than 2 lbs. of coal per hour." This certainly is "of more than ordinary significance" when it is considered that this is not only brake-horsepower, but that it involves the efficiency of a "boiler on wheels" evaporating three or four times as much water per unit of surface as a stationary boiler does.—*Book review of "Locomotive Tests and Exhibits, P. R. R.," in* POWER.

ENGINE HOUSE CONDITIONS.—To get the best service from the men doing this work it is very necessary for the foreman to see that the engine house or terminal is kept clean and neat as conditions will permit. The pits should be kept clean and free of water, dirt, rubbish and scrap material, as actual working conditions will permit. The floor should be kept clean, and all scrap material removed from engines taken away as soon as possible, to permit the men employed in inspecting and making repairs to have ample room and good facilities to carry on their work under the best conditions possible. Good lighting facilities should be provided, so that the men can see to do their work properly when working at night or at any time or place where artificial light is required.—*Mr. E. T. James, New York Railroad Club.*

CASUALTIES ON ENGLISH RAILWAYS.—The number of persons killed and injured on the railways of the United Kingdom during the year ended December 31st last were as follows: Killed, 1,100; injured, 6,460. By accidents to trains and rolling stock the number of persons killed was 39 and injured 396.—*Engineering* (London).



STANDARD 40-TON BOX CAR—ROCK ISLAND SYSTEM.



FRAMING DETAILS, STANDARD BOX CAR.—ROCK ISLAND SYSTEM.

40-TON STANDARD BOX CAR.

ROCK ISLAND SYSTEM.

The illustrations show a design of steel-frame box car recently adopted as a standard by the Rock Island and 'Frisco Lines. It is not a common standard throughout, as the two lines differ somewhat in regard to details and specialties.

The upper and lower framing is of steel similar to the Norfolk & Western composite construction, but, owing to the fact that this car is 40 ft. long inside, several modifications were introduced that may be of interest. In order to shorten the sills, the end posts and braces are attached outside of the end sill, thus economizing to the extent of about 9 ins. in the length of the main members. The side girths, of steel, are continuous from the door posts to the corners and are backed with sectional wood filling blocks. It has become a very serious problem to effectually hold the ends of wooden cars against the shocks of switching and shifting loads and these girths being attached to all side members make a very strong tie for this purpose. The design presents a very strong end with I beam intermediate posts and angle corner posts, all tied with girths and with end lining 1¾ ins. thick.

The flooring is brought down onto the top flanges of all sills and is nailed at five points. The carlines are of steel, supporting longitudinal roof boards which carry an outside steel roof. One special point in the framing is the introduction of cross bearers at the door posts to assist and strengthen the center sills, utilizing the excess of strength in the side framing. The construction of the bolsters and cross bearers, which are built up of plates and angles, is similar.

The objects sought in this design are simplicity and strength; moderate weight and utilization of standard sections and materials; stiffness of the structure to prevent weaving and movement that causes so much renailing in wooden cars; strength of end construction to eliminate a large class of repairs; to provide an under construction that will facilitate inspection and generally to provide a car that can be built, repaired and maintained with present railroad shop facilities.

The design was made in the office of Mr. C. A. Seley, mechanical engineer of the Rock Island at Chicago.

TURNING STEEL-TIRED CAR WHEELS.—The capacity of our Pond steel-tired car-wheel lathe has increased so much in the last two years, due to various improvements in the lathe and in the method of handling the work, that the former methods which we recommended no longer hold good. At the present time many of these lathes are getting out a pair of wheels an hour. We have a record of 518 pairs finished in 447 consecutive working hours. In another shop 14 pairs of wheels were finished in 10 hours. The amount the tires are worn makes very little difference in the output of the lathe, as the tread is roughed out at one cut, even though the depth of cut may be ½ to 9/16 in.—*Progress Reporter for June.*

HIGH TEMPERATURE IN GASOLINE ENGINES.—In the petrol-engine cylinder, the highest temperature reported is in the neighborhood of 4,000 deg. F. This is at the hottest portion of the exploding mixture of gas and air.—*The Engineer.*

(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE.

J. S. BONSALL,
Business Manager.

140 NASSAU STREET, NEW YORK.

R. V. WRIGHT, E. A. AVERILL, Editors.

JUNE, 1906.

Subscription.—$2.00 *a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*
Remit by Express Money Order, Draft or Post Office Order.
Subscription for this paper will be received and copies kept for sale by the
Post Office News Co., 217 Dearborn St., Chicago, Ill.
Damrell & Upham, 283 Washington St., Boston, Mass.
Philip Roeder, 307 North Fourth St., St. Louis, Mo.
R. S. Davis & Co., 346 Fifth Ave., Pittsburgh, Pa.
Century News Co., 6 Third St., S. Minneapolis, Minn.
W. Dawson & Sons, Ltd., Cannon St., Bream's Buildings, London, E. C., England.

CONTENTS.

It is very pleasant to have readers express appreciation for the good things we may do, and it spurs us on to greater efforts, but it is far more valuable to have them frankly criticise things that are not so well done. The editors of this journal invite suggestions and frank criticisms concerning the work of the editorial department. What can we do to make our pages of more value to you?

The fact that the wages of every shop foreman on a large system were recently increased is significant. With the introduction of piece-work it was no unusual thing to have piece-workers receiving a larger check at the end of the month than some of the foremen. The piece-worker by mere physical ability, with possibly a little careful thought, was receiving as much or more than those men who were doing the planning, making the improvements and carrying on the organization. The effect of the encouragement which this act of the railroad gave to the foremen cannot be overlooked. and it is to be hoped that other roads will follow the example.

It is interesting to note the changes made in two of the locomotives illustrated in this number, both of which are redesigns of classes which have been in successful operation for several years. It is noticeable first that the size and power has not been changed in either case, indicating that they are sufficiently large for the service demanded; and secondly that the Walschaert type of valve gear has been applied where the Stephenson was used before. This move has particular signficance in the case of the Lake Shore engine since this road has had the longest experience with the Walschaert gear of any in this country, and it would indicate that the gear had proved itself to have the advantages claimed for it. The application of piston valves to the Pennsylvania freight engine, where slide valves had been previously used is also worthy of notice. There has been practically no change in the boilers which apparently have proven to be satisfactory both from a capacity and maintenance standpoint.

In a valuable paper on the "Care and Maintenance of Locomotives at Terminals to give Maximum Mileage and Efficient Service" read before the New York Railroad Club by Mr. E. T. James, the following specifications were presented for a succesful roundhouse foreman. "The foreman of this highly important department should be a good, bright, energetic, trustworthy and thoroughly competent man, having had experience in repairing and caring for engines, so that he will have the required experience and judgment to decide what must be done at once, and instruct his men the proper way to do it. At times it will be necessary for him to quickly decide questions pertaining to work and in such a way that the best results will be obtained for the service. He should have the confidence of his men, should know their qualifications thoroughly, and arrange to assign the work in such a way that the men are given the work they are best adapted to perform." In the discussion which followed the reading of the paper, it was quite generally admitted that while a man who could fill these specifications would make a splendid roundhouse foreman, yet the compensation usually offered for this position was not sufficient to attract and hold such a man. This sentiment was very nicely summed up in the following incident, which was related by one of the club members at the close of the discussion. A bright young man had worked his way up to the position of roundhouse foreman and filled it with satisfaction to all concerned. He resigned to accept a place with a supply concern. Not an engineer running regularly on the division could be found who could afford to take his place and as a last resort it was offered to an engineer running a construction train. The shame lies not so much in the fact that the incident related is a true one as that it reflects a condition at present existing on a large number of railroads.

A TABULAR COMPARISON OF NOTABLE

ARRANGED WITH RESPECT

PASSENGER LOCOMOTIVES.

Type—Drivers / Type—Name	4-6-2 (PACIFIC).										2-6-2 (PRAIRIE).		
Name of railroad	O. R. & N.	Erie R.R.	A.T.&S.F.	Har'm'n Lines.	C. & A.	M.C.R.R.	So. Ry.	N. P.	N. Y. C. & H. R.	C. R. I. & P.	Pa. R.R.	L. S. & M. S.	C.B.&Q.
Road No. or class	194	2511	1251	P-141	602	K-80	1238	Q-1	K	841	2761	J-41	1950
Builder	Bald.	Amer.	Bald.	Bald.	Bald.	Amer.	Bald.	Amer.	Amer.	Amer.	Amer.	Amer.	Amer.
Simple or compound	Balance Comp.	S.-Heat. Simple	Balance Comp.	Simple.	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple
When built	1905	1905	1905	1905	1904	1904	1906	1904	1903	1905	1905	1904	1905
Tractive effort	28,300	30,000	32,800	29,920	29,900	28,500	34,940	31,000	28,500	31,000	27,520	27,800	35,050
Weight, total lbs	231,300	230,500	226,700	222,000	221,500	221,000	219,500	219,000	215,000	212,000	234,500	233,000	210,000
Weight on drivers	143,600	149,000	151,900	141,000	135,110	140,500	138,460	142,500	141,000	143,500	166,800	165,200	151,000
Weight on leading truck	43,400	41,000	35,800	37,000	40,500	42,500	39,740	39,000	36,000	34,500	27,000	26,000	22,000
Weight on trailing truck	44,300	40,500	39.000	44,000	45,490	38,000	41,300	37,500	38,000	34,000	40,700	41,800	37,000
Weight of tender loaded	159,000	163,000	.....	162,200	166,600	122,600	136,800	128,800	127,000	150,000	143,000	159,900	148,200
Whl. base, driving, ft. & ins	13-4	13-0	13-8	13-4	13-4	13-0	12-6	12-0	13-0	12-4	14-10	14-0	13-4½
Whl. base, engine, ft. & ins	33-7	33-8	34	33-4	33-4	33-7½	31-4½	32-6	33-7½	32-0	34-3	34-3	30-8½
Whl. base, engine and tender	64-1½	65-1	66-1½	63-10½	62-5½	60-5	64-5⅞	62-0½	59	61-1	64-10¼	62-4⅜	62-2¾
Driving wheels, diam., ins	77	74	73	77	77	75	72½	69	75	69	80	79	69
Cylinders, number	4	2	4	2	2	2	2	2	2	2	2	2	2
Cylinders, diameter, ins	17&28	22-½	17&28	22	22	22	22	22	22	22	21½	21½	22
Cylinders, stroke, ins	28	26	28	28	28	26	28	26	26	26	28	28	28
Heat. sur., firebox, sq. ft	179	195	192.8	174	179	180.3	195	179.4	178.65	179.41	198	222	230
Heat. sur., arch tubes, sq. ft	....	....			....	26.8	....	9	27.35		....	....	......
Heat. sur., tubes, sq. ft	2,874	3,131	3,402.2	2,874	2,874	3,690.6	3,683.5	3,361	3570	3,174.5	3,677.9	3679	3,353.4
Heat. sur., total, sq. ft	3,055	3,326	3,595	3,048	3,053	3,897.7	3,878.5	3,549.4	3,776	3,353.92	3,976	3901	3,583.4
Firebox, length, ins	108	108⅛	108	108	108	96⅛	108⅛	96	96⅛	96 1-16	108⅛	108⅛	108⅛
Firebox, width, ins	66	75¼	71¼	66	66	75¼	72¼	65¼	75¼	67¼	73¼	73¼	72¼
Grate area, sq. ft	49.5	56.5	53	49.5	49.5	50.23	54.25	43.5	50.23	44.8	55	55	54.25
Boiler, smallest diam., ins	70	74⅝	70	70	70	72-1/16	70	70⅝	70⅝	68⅜	73	70	70
Boiler, height center	....	113½		9-5	113	113	109	115	113	113½	9-8½	114	8-11⅜
Tubes, No. and diam. in ins	245-2¼	195-2¼ 32-5	290-2¼	245-2½	245-2¼	354-2	314-2¼	374-2	303-2¼	328-2	322-2¼	322-2¼	301-2¼
Tubes, length, ft. and ins	20-0	20-0	20-0	20-0	20-0	20-0	20-0	18-6	20-0	18-7	19-5	19-6	19-0
Steam pressure, lbs., per sq. in	200	200	220	200	200	200	220	200	200	200	200	200	210
Type of boiler	Str.	Str.	W. T.	Str.	Str.	Str.	Str.	E.W.T.	Str.	E.W.T.	Str.	E.W.T.	Str.
Fuel	Bit.	Bit.	Oil	Oil or Coal	Bit.	Bit.	Bit.	Bit	Bit.	Bit.	Bit.	Bit.	Bit.
Tender, coal capacity, tons	10	16	3,300	12	15	10	12½	12	10	13	13½	15	13
Tender, water capacity, gals	9,000	8,500	8,500	9,000	8,400	6,000	7,500	6,000	6,000	7,500	7,000	8,000	8,000
Reference in the American Engineer	1905, p. 246	1905, p. 172	1905, p. 454	1905, p. 154	1904, p. 133	1904, p. 347	1906, p. 145	1905, p. 8	1904, p. 87	1905, p. 282	1906, p. 73	1904, p. 413	1905, p. 78

FREIGHT LOCOMOTIVES.

Type—Drivers / Type—Name	0-6-6-0 Mallet	2-10-2 Santa Fe	2-10-0 (DECAPOD.)		2-8-2 (MIKADO).			2-8-0 (CONSOLIDATION.)					
Name of railroad	B. & O.	A. T. & S. F.	A. T. & S. F.	M.St.P. &S.S.M.	N. P.	A. T. & S. F.	N. P.	P.B.& L.E.	L. S. & M. S.	Lehigh Valley	N. Y. C. & H. R.	L. S. & M. S.	N. Y. C. & H. R.
Road No. or class	2400	900	987	600	W. (com.)	885	1554	150	G-46	1301-15	G-4	G-5	G-5 F.
Builder	Amer.	Bald.	Bald.	Bald.	Amer.	Bald.	Amer.	Pitts.	Amer.	Bald.	Amer.	Amer.	Amer.
Simple or compound	Comp.	Tan. Comp.	Tan. Comp.	Vauc. Comp.	Tan. Comp.	Vauc. Comp.	Simple	Simple	Simple	Vauc. Comp.	Tan. Comp.	Simple	Simple
When built	1904	1903	1902	1900	1905	1902	1905	1900	1903-4	1898-9	1903	1904	1905
Tractive effort	70,000	62,800	62,500	48,600	45,000	55,600	46,630	63,800	46,500	47,700	46,600	45,700	45,700
Weight, total lbs	334,500	287,240	266,500	210,000	271,000	261,720	259,000	250,300	230,000	228,082	225,000	220,200	220,200
Weight on drivers	334,500	234,580	237,000	185,100	207,000	199,670	203,000	225,200	203,000	205,232	200,000	200,000	200,000
Weight on leading truck	....	23,420	29,500	24,900	30,300	27,250	25,400	25,100	27,000	22,850	25,000	20,200	20,200
Weight on trailing truck	....	29,240	....	....	33,700	34,800	30,600	....		......	....	....	....
Weight of tender loaded	143,000	158,500	132,000	124,550	148,500	136,000	148,500	141,000	148,000	148,000	137,500	140,000	141,600
Whl. base, driving, ft. & ins	30-8	19-9	20-4	19-4	16-6	16-0	16-6	15-7	17-3	15-0	15-0	17-0	17-6
Whl. base, engine, ft. & ins	30-8	35-11	29-10	28-0	34-9	31-6½	34-9	24-4	26-5	23-10	23-7	25-11	26-5
Whl. base, engine and tender	64-7	66-0	59-6	58-3	63-1	59-5½	63-1	57-11¾	57-9¾	57-10¼	59-1	60-7	60-6½
Driving wheels, diam., ins	56	57	57	55	63	57	63	54	58	55½	51	63	63
Cylinders, number	4	4	4	4	4	4	2	2	2	4	4	2	2
Cylinders, diameter, ins	20&32	19&32	19&32	17&28	19&30	18&30	24	24	23	18&30	16&30	23	23
Cylinders, stroke, ins	32	32	32	32	30	32	30	32	30	30	30	32	32
Heat. sur., firebox, sq. ft	220	209	210.3	191.96	200	210.3	200	241	232	193	201	220	185.64
Heat. sur., arch tubes, sq. ft	....	....	23.9	....	9		9		....	......	26	....	27.41
Heat. sur., tubes, sq. ft	5,380	4,587	5,155.8	2,808.04	3,819	5,155.8	3,819	3,564	3,725	3,952	3,915	3,717	3,512
Heat. sur., total, sq. ft	5,600	4,796	5,390	3,000	4,028	5,366.1	4,028	3,805	3,957	4,145	4,142	3,937	3,702.52
Firebox, length, ins	108⅛	108	108	132	96	108	96	132	108	120	105⅛	105-1/16	108 1/16
Firebox, width, ins	96¼	78	78	41	65¼	78	65¼	40¼	73¼	108	79⅝	75¼	75¼
Grate area, sq. ft	72.2	58.5	58.5	37.5	43.5	58.5	43.5	36.8	55	90	58	54.9	56.47
Boiler, smallest diam., ins	84	78¾	78.75	68	75¾	78¾	75¾	84	80	80	77	81⅝	80
Boiler, height center	10-0	9-10	9-10	107	118	9-10	118	119¾	119½	103⅜	111	114	117
Tubes, No. and diam. in ins	436-2¼	391-2¼	463-2¼	344-2	374-2	463-2¼	374-2	406-2¼	461-2	502-2	507-2	458-2	446-2
Tubes, length, ft. and ins	20-10¾	20-0	19-0	15-7	19-6	19-0	19-6	15-0	15-6⅛	15-0⅞	14-9	15-6	15-0½
Steam pressure, lbs., per sq. in	235	225	210	215	200	225	200	220	200	200	200	200	200
Type of boiler	Str.	W. T.	W. T.	E.W.T.	E.W.T.	W. T.	E.W.T.	Str.	W. T.	Wooten	E.W.T.	Str.	Str.
Fuel	Bit.	Bit.	Bit.	Bit.	Bit.	Bit.	Bit.	Bit.	Bit.	Anth.	Bit.	Bit.	Bit.
Tender, coal capacity, tons	16	14	11	9	12	12	12	14	16	12	12	12	12
Tender, water capacity, gals	7,000	8,500	7,000	7,000	8,000	7,000	8,000	7,500	7,500	7,500	7,000	7,500	7,500
Reference in the American Engineer	1904, p. 237&262	'03, pp.372 & 398 '04 p.176	1902, p. 192	1900, p. 319	1905, p. 367	1903, pp. 16&109	1905, p. 5	1900, p. 214	1903, pp. 416&439 '04,p.12	1898, p. 395	1903, p. 174	1905, p. 46	1905, p. 214

NOTE.—These figures have been verified by the railroad officials in charge.

EXAMPLES OF RECENT LOCOMOTIVES.

TO CLASSES AND WEIGHTS.

PASSENGER LOCOMOTIVES.

4-4-2 (ATLANTIC).											4-6-0 (TEN WHEEL).			4-4-0 (AMERICAN).	
Erie R.R.	N. Y. C. & H. R.	Erie R.R.	Pa. R. R.	Pa. R.R.	N. Y. C. & H. R.	C. B.&Q.	Harrim'n Lines.	C.R.I. & P.	C. R. I. & P.	Pa. R. R.	D.L.&W.	N. Y. C. & H. R.	D.&H. Co.	C. R. R. of N. J.	D.L.&W.
537	I	535	2760	2759	I-1	2700	A81	1048	1019	2512	1012	2099	502	852	955
Amer.	Bald.	Bald.	Amer.	Bald.	Amer.	Bald.	Bald.	Bald.	Amer.	Soc.Als.	Amer.	Amer.	Amer.	Amer.	Amer.
Balance	Balance	Balance	Balance	Balance	Balance	Balance	Simple	Balance	Simple	DeGlehn	Simple	Simple	Simple	Simple	Simple
Comp.	Comp.	Comp.	Comp.	Comp.	Comp.	Comp.		Comp.	S-Heat	Comp.					
1905	1905	1905	1905	1905	1904	1904	1905	1905	1905	1904	1905	1905	1903	1905	1905
23,860	24,200	28,000	23,300	23,300	24,000	21,400	23,560	24,000	24,700	19,530	35,100	31,000	27,100	23,120	23,710
206,000	204,500	204,200	200,500	200,400	200,000	196,600	196,000	195,000	191,300	164,000	201,000	194,500	175,000	161,300	151,200
115,000	110,000	113,500	117,200	119,600	110,000	101,200	105,000	102,000	107,100	87,850	154,000	148,000	131,500	111,300	100,000
52,000	52,400	47,500	52,500	46,500	50,000	54,200	45,000	51,780	42,400	41,250	47,000	46,500	43,500	50,000	51,200
39,000	42,100	41,200	30,000	34,300	40,000	41,200	46,000	42,080	40,800	34,900	....	....	....	....	....
162,800	124,000	155,000	132,500	132,500	124,000	120,400	162,200	144,000	144,000	132,500	120,000	143,500	120,166	122,200	110,000
7-0	7-0	7-0	7-5	7-5	7-0	7-3	7-0	6-10	7-0	7-0½	14-4	15-10	15-0	8-3	8-6
28-9	30-9	30-1	31-11	33-8	27-9	30-2	27-7	30-3	27-5½	28-6 9/16	25-6	26-10½	26-4	23-1½	24-5
60-9	56-8	59-10½	61-4 1/16	63-1 1/16	53-8	57-6¾	58-2	....	57-2	59-5	54-0¼	59-2	53-7½	49-2	51-0⅝
78	79	72	80	80	79	78	81	73	73	80 5/16	69	69	72	69	69
4	4	4	4	4	4	4	2	4	2	4	2	2	2	2	2
15½&26	15½&26	16 & 27	16 & 27	16 & 27	15½&26	15 & 25	20	15&25	21	14 3/16 & 23⅝	22½	22	21	19	20
26	26	26	26	26	26	26	28	26	26	25 3/16	26	26	26	26	26
181.1	175	181	181.4	166	175	155.5	174	194	161.8	181.1	221.7	180.3	179.68	167.6	190.8
......	23		......	......	23	......	....	....	....	....	....	22.7	78.54	....	
3,453.6	3,465	3,458	2,680	2,698	3,267	3,050.5	2,475	3,048	2,227.56	2,435.7	3,156.3	3,124	2,405.5	1,838.1	1,947.89
3,634.7	3,663	3,639	2,861.6	2,864	3,465	3,206	2,649	3,242	2,389.36	2,616.8	3,378.0	3,327	2,663.72	2,005.7	2,138.69
108⅛	96⅛	108⅛	111	111	96⅛	96⅛	108	107 1/16	96 1/16	119⅞	126⅛	105⅛	119⅞	122⅛	126 3/16
75¼	75¼	72	72	72	75¼	66¼	66	67¼	67¼	40	108¼	75¼	102	96¼	100
56.5	50.3	54	55.5	55.5	50.23	44.14	49.5	50.2	44.8	33.9	94.8	54.93	84.85	81.6	87.54
70¾	70⅝	68	65⅝	65⅝	70⅝	64	70	66	72	59⅝	74⅝	70⅝	66¼	62¼	61 3/16
111⅝	9-3	9-2	9-1	9-1	11-1/16	9-⅛	9-5	107	108	8-10 5/16	116½	9-7	113	113	
388-2	318-2¼	309-2¼	315-2	261-2¼	390-2	264-2¼	297-2	273-2¼	173-2 54-3½	139 2 13/16	398-2	400-2	308-2	280-2	280-2
17-0	18-6	19-0	16-3	17-7	16-0	19-0	16-0	18-10	16-0	14-5¼	15-3	14-11	15	12-6	13-4¼
220	220	225	205	205	220	210	200	220	185	227½	215	200	200	200	185
E. W. T.	Str.	W. T.	Belpaire	Belpaire	Str.	W. T.	Str.	W. T.	Str.	Belpaire	Str.	W. T.		W. T.	Str.
Bit.	Bit.	Bit.	Bit.	Bit.	Bit.	Bit.	Coal or Oil	Bit.	Bit.	Bit.	Anth.	Bit.	Culm.	Anth.	Anth.
16	10	12	12½	12½	10	12	10	12	12	12½	10	12	12	12	10
8,500	6,000	8,500	5,500	5,500	6,000	6,000	9,000	7,000	7,000	5,500	6,000	7,000	6,800	5,000	5,000
1905 p.	1905, p.	1905, p.	1906, p.	1906, p.	1904, p.	1904, p.	1905, p.	1905, p.	1905, p.	1904, p.	1905, p.	1906, p.	1903, p.		
287	109	177	73	73	166	212	154	416	329	203	407	59	285		

FREIGHT LOCOMOTIVES.

2-8-0 (CONSOLIDATION).								4-6-0 (TEN WHEEL).			0-10-0	0-8-0	0-6-0 (SWITCHER).		
Pa. R.R.	A. T. & S. F.	N. P.	B. & O.	Har'm'n Lines.	"Soo Line."	N. Y. C. & H. R.	C. P. R.	C. P. R.	C.&E.I.	C. R. I. & P.	L. S. & M. S.	C. & O.	P. R. R.	Har'm'n Line.	C. R. I. & P.
2762	824	....	2503	C-187	445	G-2	1621	1300	289	1554	M.	8	B-6	S-150	114
Amer.	Bald.	Amer.	Amer.	Bald.	Amer.	Schen.	Amer.	Amer.	Bald.	Bald.	Amer.	Amer.	P. R. R.	Bald	Amer.
Simple	Vauc.	Tan.	Simple	Simple	S.-Heat.	2-cyl.	S.-Heat.	S.-Heat.	Bal.	Simple	Simple	Simple	Simple	Simple	Simple
	Comp.	Comp.			Comp.	Comp.	Simple	Comp.	Comp.						
1905	1902	1901	1905	1905	1905	1901	1904	1903	1905	1905	1905	1903	1904	1905	1905
45,700	45,300	44,900	41,100	43,299	37,300	39,300	36,800	31,200	31,000	34,000	55,300	41	36,100	27,915	31,300
220,000	214,600	209,500	208,500	208,000	201,500	192,000	186,525	192,020	191,060	173,720	270,000	171,175	170,000	150,000	138,500
198,000	191,400	185,500	185,900	187,000	174,000	166,000	164,000	141,095	145,260	131,200	270,000	171,175	170,000	150,000	138,500
22,000	23,200	24,000	22,600	21,000	27,500	26,000	22,525	50,925	45,800	42,520	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
140,500	110,000	......	143,500	135,050	116,900	114,000	125,700	122,000	120,000	144,000	....	121,160	132,500	85,100	41,600
17-6	15-4	15-0	16-8	15-8	17-0	17-0	15-10	14-10	13-6	15-0	19-0	13-7½	11-6	11-4	11-0
26-5	24-6	23-8	25-7	24-4	25-11	25-11	24-4½	26-1	27-7	26-6	19-0	13-7½	11-6	11-4	11-0
60-3¾	54-2¾	52-4½	59-8¼	55-11¾	55-8¼	53-11	53-4¼	54-6	55-8	56-5½	54-5½	45-8	48-3¼	42-9	41-10
63	57	55	60	57	63	63	57	62	62	63	52	51	56	57	51
2	4	4	2	2	2	2	2	2	4	2	2	2	2	2	2
23	17&28	15&28	22	22	23&35	23&35	21	22&35	15½&26	22	24	21	22	20	19
32	32	34	30	30	34	34	28	30	26	26	28	28	24	26	26
182	235	173	179.3	177	158	155.4	166	180	160.7	160.8	197	164	152.1	150	100
....	....	22.9	....	....	....	27.1	340	390	....	....	....	....	....	....	....
3,600	4,031	3,450.4	2,630.1	3,226	2,407.5	3,298.1	2,493.7	3,312.6	2,933.7	2,426	4,422.6	2,573	2,343	1,650	1,862
3,782	4,266	3,646.3	2,809.4	3,403	2,565.5	3,480.6	2,659.7	2,492.6	3,094.4	2,586.8	4,619.6	2,737	2,495.1	1,800	1,962
106 1/16	84	100 1/16	107⅝	108	96⅛	96⅛	96⅝	102⅞	101⅞	96¼	108⅛	80	90	108	60
75¼	3-28 dia.	75¼	75¼	66	70¼	75⅝	65¼	70¼	66	67¼	73¼	70	66	40¼	68
55.4	.....	52.3	56.24	49.5	46.8	50.3	43.8	49.82	46.69	44.9	55.4	38.8	41.25	30.2	28
80	74	75	74.5	80	67⅝	70⅝	70⅝	70½	64	68	80 1/16	67	67¼	70	62⅛
9-9	9-2	111¼	118	9-6	115	115	111½	111½	109	112	115	112½	....	8-7	....
446-2	652-1¾	442-2	282-2¼	413-2	224-2 40-3½	396-2	55-3 255-2	248-2 22-5	278-2¼	329-2	447-2	351-2	325-2	276-2	237-2
15-4¾	13-7	15-0	15-10	15	15-9	16-0	14-2½	14-7	18-0	14-2	19-0	14-0	13-10¼	11-6	15-0
200	210	200	205	200	210	210	200	200	225	185	210	200	205	180	200
Str.	E.W.T.	E.W.T.	Str.	Str.	E.W.T.	Str.	W. T.	W. T.	W. T.	W. T.	W. T.	W. T.	Belpaire	Str.	Str.
Bit.	Oil	Bit.	Bit	Bit.	Bit.	Bit.	Bit.	Bit.	Bit.	Bit.	Bit.	Bit.	Bit.	Bit.	Bit.
13½	2,200	10	15	14	10	10	12	10	12	12	12	7	11	6	6½
7,000	6,000	5,500	7,000	7,000	6,000	5,000	5,000	5,000	6,000	7,000	8,000	6,000	5,500	4,000	5,000
1906, p.	1902, p.		1906, p.	1905, p.	1905, p	1901, p.	1904, p.	1903, p.	1905, p.	1905, p.	1905, p.	1904, p.	1904, p.	1905, p.	1905, p.
73	10		31	154	150	83	454	317	97	362	330	184	384	154	443

The value of forging and bulldozing machines in increasing the efficiency and output of the smith shop is being very generally recognized by the railroad shop managements. These machines are, of course, of very little worth unless they are properly equipped with the dies and special devices for doing the work. The results which may be obtained by having a capable die maker placed in charge of this work are wonderful. In one large shop, where this was done, the first year showed an increase in tonnage of the forgings manufactured of 300 per cent. over the preceding year with the same machines and the same force of men at work, and at least 75 per cent. of this was due entirely to the development of special tools and dies for use with the forging machines and bulldozers.

"I don't want any more men fresh from college in my drawing room, they have got to be tried out a little and worked down to bed rock before I will waste time on any more of them." Thus writes a mechanical engineer of a prominent railroad. Investigation showed that except for the chief draftsman and a leading draftsmen he had weeded out practically all of the college men in the drafting room, and substituted in their place practical men who had taken a correspondence school course. His reasons were that the greater number of college men just from school, or even with more or less experience in the shops do not seem to have much of an idea as to how to apply their theoretical knowledge. They cannot be intrusted with important work and must be very closely watched and directed; as soon as they get to a point where they are of some value they become too big for the job and are anxious to get a better paying position.

The correspondence school man with some shop experience is even more helpless at the outset, but while he may never become as valuable as the college graduate he is quick to learn, and after he has got a good start is content to remain where he is until he has earned his promotion. His ideas as to compensation are much more reasonable than those of the college graduate, and, if there is a fair chance of promotion he is willing to work hard for it, and on the whole, is much more contented than the college graduate under similar circumstances. It is very poor policy to constantly keep changing the personnel of a drafting room force. When once a man becomes acquainted with the office methods and records he becomes a valuable asset, and it would appear to be good policy to select and train men who would stay in the office long enough to pay for the trouble and expense of "breaking them in."

The railroads do not have facilities for building steel cars, and this, in addition to the fact that these cars are practically blanketed with patents, and that in many cases the builders have special facilities for using certain shapes of material or types of construction, has possibly led many of the railroads, ordering steel cars, to leave the question of design to a too great extent in the hands of the engineering department of the car builder. Unless the mechanical department of each railroad very carefully checks the builder's designs various features creep in which are a source of annoyance and expense until they are remedied. It is to be regretted that in many cases the builders seem to forget that the cars ever have to be repaired, or that the railroad company is not as well equipped with special devices for doing the work as are the car builders. Again it quite often happens that a device or construction which may appear to be theoretically correct works out all wrong in practice. The car department spends its entire time in repairing and keeping the cars in running condition, and surely the experience thus gained should be used to check the work of the car designer, who is often a man skilled in the theory of mechanics, but with no practical experience in car work. Conditions in the operation of trains and the size and power of locomotives are constantly changing, and the effect of these upon the cars very soon become apparent to the officials of the car department, and this knowledge should be used in connection with the ordering of new cars. Each road also has peculiar conditions to contend with, and it is not to be expected that the car company's engineers can keep in close touch with these. The above is not intended as a criticism of the car designer, but rather to draw the attention of the railroads to the importance of carefully checking all designs for new equipment.

That the railroads are at last waking up to the importance of systematically and carefully looking after the shop apprentices is apparent. In some instances instruction is being given in mechanical drawing and mathematics, attendance at the classes being compulsory. In other cases the work of the apprentices is being more carefully supervised. One large system has even gone so far as to make a liberal appropriation for improving the condition of the apprentices and giving them the opportunity of bettering themselves, and thus becoming more valuable to the company. It was just a year ago that Mr. Basford presented his valuable paper on "The Technical Education of Railway Employees" before the Master Mechanics' Association, and, doubtless it has had much to do with the impetus which this movement seems to have gained during the year.

In one large shop where special efforts were made to supervise the work of the boys the results have been very gratifying. This shop has about thirty machine apprentices and a good mechanic has been placed in charge of them and devotes his entire time to instructing and coaching them in their work. The result of this improvement immediately became apparent in the better grade of work and the increased quantity turned out by the apprentices. The workmen look with considerable favor on the change and do all they can to make it a success. They are glad to see the boys taking advantage of an opportunity they never had, and which they realize would have improved their condition and increased their opportunities for advancement. A result which was not looked for, but which is important, was that the man first placed in charge of the boys developed so rapidly in executive ability that he was promoted and given a foremanship. Great care should be taken in selecting a man for this position. He must be one who can sympathize with the boys and look at things from their point of view; he must possess more than the usual amount of tact and push, and must be able to interest them in their work. Even if the railroads look at the question from the standpoint of immediate returns they will be amply repaid for installing a system such as the one just described, especially if classes in mechanical drawing and mathematics are carried on in connection with it.

The three most notable innovations applied to American locomotives during the past few years are the arrangement of cylinders on the balanced principle, the use of superheated steam and the Walschaert type of valve gear. The first of these thus far in this country has only been used on compound locomotives where, because of the different size of the two cylinders on the same side of the engine, it is not possible to attain exact balance. However, even under these circumstances most favorable reports have been given from the operation of this type, both in regard to its smoother riding and operation, as well as the better distribution of its power, and it seems safe to say that the balanced principle for high speed locomotives is an entire success, and, that it will undoubtedly be extended and become general for this type of power. The second of these new features, that of superheating, while not having been quite so widely tried in this country as the balanced principle, has nevertheless been reported to be an entire success with the proper design of superheater. Its chief value lies in the reduction of condensation in the cylinders, the more rapid and freer movement of superheated steam through the passages and the fact that superheated steam is a very poor conductor of heat, all of which tend

to allow a larger proportion of the heat in the steam to be transformed into useful work. The Walschaert valve gear has made a most favorable impression in this country for both fast and slow locomotives and has undoubtedly come to stay.

So far as we know these three devices or principles have not all been applied to any single locomotive in this country, but we illustrate elsewhere in this issue a locomotive built for the Belgium State Railways, which incorporates all three of them and makes further improvement in obtaining exact balance by the use of four equal cylinders, all connected to the same pair of drivers. These four cylinders are each operated on the simple principle and have their valves so inter-connected that each will give exactly the same power; thus presenting ideal conditions of balance.

The use of four simple cylinders with four separate valves, a duplication of passages and a general complication of the cylinder castings and connections would seem to present a number of disadvantages from the standpoint of steam economy, which in themselves might be great enough to overcome the advantage to be obtained by the perfect balance of the reciprocating parts. However, the use of superheated steam gives conditions which nullify to a large extent these disadvantages, and prevents the larger surfaces of cylinders and passages from giving the trouble with condensation they would be expected to give with saturated steam. The possibilities of this combination are attractive and should receive the serious consideration of motive power men, who are looking for further improvement in our high speed locomotives

AMERICAN ENGINEER TESTS ON LOCOMOTIVE DRAFT APPLIANCES.

An elaborate series of tests on locomotive draft appliances were made in 1894 in Hanover, Germany, by Messrs. Von Borries and Troske (AMERICAN ENGINEER AND RAILROAD JOURNAL, 1896). The Master Mechanics' committee on Exhaust Nozzles and Steam Passages presented excellent reports on these subjects in 1894 and 1896, the tests being made on an actual locomotive on a testing plant. In the AMERICAN ENGINEER AND RAILROAD JOURNAL, June, 1900, Mr. H. H. Vaughan presented an article in which the need of further and more exhaustive tests on front-end arrangements was discussed. In 1901 the AMERICAN ENGINEER AND RAILROAD JOURNAL conducted an extensive series of tests on locomotive draft appliances at Purdue University, the results of which were presented in this journal during the years 1901, 1902 and 1903. At the 1902 Master Mechanics' convention a committee was appointed to assist the AMERICAN ENGINEER AND RAILROAD JOURNAL in carrying out these tests. At the 1905 meeting of the Association the committee reported that liberal contributions had been received from over 70 railroads and from the two leading locomotive companies for carrying the tests to completion. A recommendation was made by the committee, and adopted by the Association, that the results of these tests should be published in the AMERICAN ENGINEER AND RAILROAD JOURNAL when they were concluded. The committee has just completed its work and presents the following report. An appendix, which accompanies the report, gives a more elaborate presentation of methods and results:

REPORT OF COMMITTEE ON LOCOMOTIVE FRONT-ENDS.

To the President and Members of the Master Mechanics' Association:

The undersigned, your committee, appointed to "assist in the tests being conducted at Purdue University, Lafayette, Ind., by the AMERICAN ENGINEER AND RAILROAD JOURNAL, and to carry on the tests outlined in its report to the convention in 1903," respectfully submit the following:

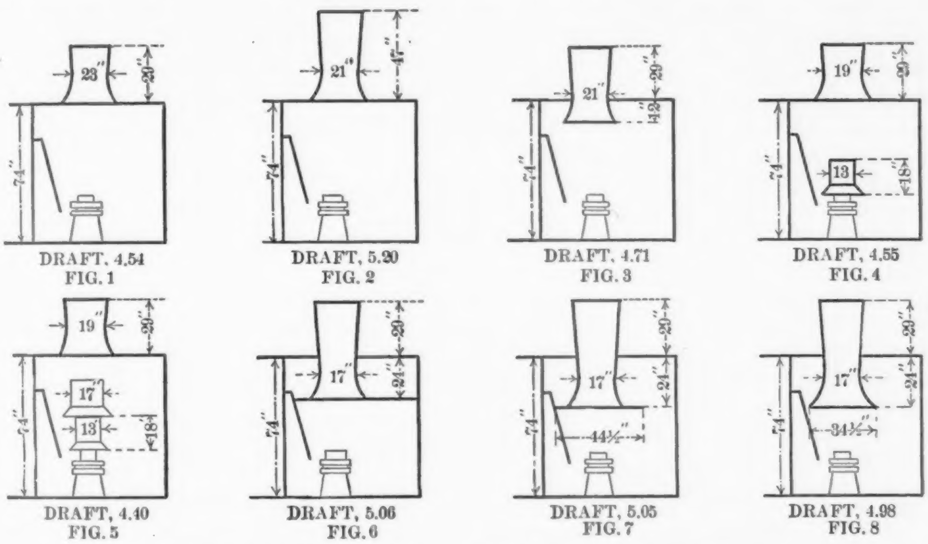
Historic Statement.—The Association as early as 1890 had appointed a committee to report on the best forms of exhaust-nozzles and steam-passages. This committee, after making one report, and after being continued for several years, finally gave way to a new committee under the chairmanship of Mr. Robert Quayle, with the result that in 1896 an epoch-making report was presented. The work of this committee settled two important questions, viz., the action of the exhaust-jet and the form and proportions of the exhaust-pipes and nozzles.

In 1901 the AMERICAN ENGINEER AND RAILROAD JOURNAL became the patron of Purdue University for the purpose of advancing an experimental study embracing the form and proportion of locomotive stacks, and invited and secured as an advisory committee the assistance of distinguished motive power officials. By virtue of this arrangement an elaborate investigation was planned and completed, with results which were expressed in the form of general equations, by the use of which it was assumed that the stack for any engine might be correctly proportioned. The results of this investigation appeared in the columns of the AMERICAN ENGINEER AND RAILROAD JOURNAL during the following year. These experiments, however, were made upon an engine having a diameter of boiler of but 52 ins., which is far less than that of the modern locomotive, and they were chiefly concerned with the problem of the outside stack. In consequence of these facts there was a common desire to have the experiments repeated upon a locomotive of large size, and to have the study extended to include the draft-pipe problem, the effect of inside stacks and of false tops in the smoke arch. In response to this feeling the Association in June, 1902, laid the foundation for the work which finds its completion in the present report. It was at this time that your committee was appointed. A year later the committee made a report, giving a summary of the work already accomplished, and presenting an outline of such additional work as was most needed. It reported that Purdue was ready to proceed with the work, that the New York Central Railway Company was prepared to loan an engine of large size for the use of the committee, and they submitted an estimate of the cost of the experiments they proposed. This report was received, and the committee continued for another year, since which time it has each year made a report of progress and has been continued. New York Central Atlantic type locomotive No. 3929 was delivered to the University Laboratory in November, 1905, and continued to occupy the testing laboratory until the following April. During this interval there were obtained the results herein described.

Co-operating Influences.—First among those to whom acknowledgment is due is the AMERICAN ENGINEER AND RAILROAD JOURNAL, by whose enterprise the original investigation was outlined and by whose efforts substantial progress in its development was achieved. While its formal contribution has long since been submitted, its interest has not failed, and your committee acknowledge with pleasure the assistance which from time to time has been rendered by representatives of this journal. The Standard Oil Company has presented your committee with one of the several carloads of fuel oil needed. Seventy-four railway companies made contributions of money to meet necessary expenses. The New York Central lines have contributed, without charge, the use of a locomotive for a period of 5 months; they have delivered the locomotive to the University laboratory, and received it back again from the laboratory, without expense to your committee. They have also made the necessary experimental stacks and draft-pipes from drawings supplied by your committee and fitted the same to the engine upon which they were to be used. Purdue University has contributed the use of its laboratory and the time of its expert staff, the costs to your committee having been only such as have arisen from the supplies consumed and the time of necessary extra attendants. The tests have been under the direct supervision of Professor W. O. Teague, Assistant Professor of Experimental Engineering, whose report, which accompanies, covers all details of the tests. It is the understanding of your committee also that Professor Teague has been enthusiastically assisted by Mr. L. E. Endsley, Instructor in Engineering Laboratory in charge of the locomotive testing plant. To all of these, as well as to others, too numerous to mention, your

committee respectfully acknowledges its indebtedness and returns its thanks.

Outside Stacks.—The tests of outside stacks involved two different heights, namely, 29 and 47 ins. The 29-in. height only is practicable for road conditions upon the locomotive under test. Stacks of each of these heights were supplied in diameters ranging from 15 to 21 ins. by 2-in. steps, and as the work proceeded it seemed desirable to extend the range with the result that, in the 29-in. height, stacks of 23 and 25-in. diameter respectively were added to the series. In these tests no draft-pipes nor nettings were employed in the front-end; the diaphragm and exhaust-pipe were the only details present. Under these conditions, with a 29-in. height, the best diameter was found to be 23 ins., though this was not much better than that of 21 ins. With a 47-in. height the best diameter is 21 ins. The exact arrangement of equipment for the best results is shown by Figs. 1 and 2. The notation under these figures and under those which immediately follow gives the draft obtained with a constant back pressure of 3.5 lbs. It will hereafter appear that there are better arrangements than that shown by Fig. 1. The point which is proven is that, assuming a plain outside stack 29 ins. high to be used, its diameter for the best results is 23 ins., as given.



DRAFT, 4.54 FIG. 1 — DRAFT, 5.20 FIG. 2 — DRAFT, 4.71 FIG. 3 — DRAFT, 4.55 FIG. 4
DRAFT, 4.40 FIG. 5 — DRAFT, 5.06 FIG. 6 — DRAFT, 5.05 FIG. 7 — DRAFT, 4.98 FIG. 8

BEST ARRANGEMENT OF EACH TYPE OF FRONT END TESTED.

A Comparison of Results Obtained From a Large Locomotive With Those Previously Obtained From a Smaller Locomotive.—Among the more important conclusions drawn from the AMERICAN ENGINEER'S tests of 1903, the following are of especial interest in connection with the present discussion:

That for a tapered stack, the diameter for best results does not change with changes in height.

That the diameter of stack is somewhat affected by the height of the exhaust tip, the diameter for the best results being greater as the nozzle tip is lowered.

That, calling *d* the diameter of the stack at its smallest part, and D the diameter of the front-end, the relation between the diameter of stack and front-end when the exhaust tip is at the center of the boiler is

$$d = .25D$$

That the diameter of stack must, for best results, be increased .16 in. for each inch that the exhaust tip is below the center-line of the boiler; that is, calling *h* the distance between the center-line and the tip.

$$d = .25D + .16\,h.$$

That a variation of an inch or more from the diameters given by the equation will produce no unfavorable result.

In view of the publicity that has been given these statements, it is important to determine the extent to which their truth is affected by the experiments of the present year.

As to the necessity for varying the diameter with the height of stack, the work of the past year is far less elaborate than that of 1903, but two heights of stack having been employed, namely, those of 29 and 47 ins. respectively. Comparing draft-values obtained from stacks of each of these heights under a uniform back pressure of 3.5 lbs., it appears that the best diameter for the 29-in. stack is 23 ins. The best results from the 47-in. stack were obtained by use of the largest diameter experimented upon (21 ins.). Curves plotted through the several points show this diameter to approach that for the maximum draft, but it does not equal it. The indication is that if a diameter of 23 ins. had been employed it would have been found right for the 47-in. height as well as for the 29-in. height. There is, in fact, nothing in the experiments of the present year to invalidate the conclusion derived from the preceding work. So far as outside stacks are concerned, therefore, the diameter does not need to be varied when the height is changed.

As to the effect, upon the proportions of stack, resulting from changes in the height of the exhaust tip, it must be noted that the work of the present year has involved one height of tip only, and hence gives no information upon this question. The validity of the conclusion already stated, however, has never been called in question, and it may be assumed to stand.

Concerning the actual size of stack for best results, the work of the present year points to the desirability of using diameters which are somewhat larger than those given by the equation of 1903. This equation is

$$d = .25D + .16\,h.$$

which, when applied to the N. Y. C. locomotive experimented upon, gives

$$d = .25 \times 74 + .16 \times 12.5 = 18.5 + 2.0 = 20.5$$

whereas, with a stack 29 ins. high, the best results were actually obtained when the diameter was 23 ins. The difference of 2.5 ins. is not great, especially in view of the fact that it has been distinctly noted that variation of an inch or more is not important. The difference is to be accounted for also by the fact that in reviewing the results of 1903 there was a common feeling on the part of the members of the advisory committee that the experiments pointed to dimensions which, for service conditions, were excessive. Because of this view, the equation was framed as a conservative expression of the experimental results. The data obtained during the present year might, for like reasons, be similarily treated, in which case the discrepancy of 2.5 ins. would be diminished or even be eliminated. Since, therefore, the only element of doubt concerning the results of 1903 has found expression in beliefs that they gave diameters which were too large, it is the feeling of your committee that the work of the present year may be accepted as a full confirmation of the earlier work.

Having shown the value of the work of the present year in confirming the conclusions of 1903, it remains to consider those phases of the present year's work which are to be regarded as extending beyond the scope of the earlier investigations; the effect of which necessarily diminishes the importance of that which has preceded. It will be shown that, however well the plain outside stack may be proportioned, the demands of service require it to give way to a more highly articulated device.

Inside Stacks.—The experiments included inside stacks of four different diameters, ranging from 15 to 21 ins., a constant outside height of 29 ins. and a penetration into the smokebox of 12, 24 and 36 ins. respectively. The best proportions of this form of stack are shown by Fig. 3 accompanying. Its diameter is 21 ins. and its penetration (P) into the smokebox is 12 ins. Results of nearly the same value were, however, obtained with stacks of smaller diameter

having greater penetration. Thus, 21-in. diameter, 12-in. penetration, gave a draft of 4.71; 19-in. diameter, 24-in. penetration, gave a draft of 4.55, and 17-in. diameter, 36-in. penetration, gave a draft of 4.32. From the values thus presented it appears that as the degree of penetration increases the diameter of stack should be reduced. The effect is, in fact, of the same nature and degree as that which results from raising the exhaust-tip. It is noteworthy also that these values for the plain inside stack are not materially better than those for the plain outside stack, a fact which was formulated as a conclusion resulting from the work of 1903.

Inside Stack With False Top.—It had been planned to fit the front-end with three different false tops located at 12, 24 and 36 ins. respectively from the top of smokebox, but the presence of the steam pipes made it difficult to fit the 12-in. top, and as a consequence only the 24- and 36in. drops were experimented upon. In each case stacks of different diameters were used, the outside height being always 29 ins. The best results were obtained with a stack 17 ins. in diameter, having a penetration of 24 ins., all as shown by Fig. 6. In all cases with the false top the 17-in. stacks gave best results. A comparison of these results with those quoted for plain outside stack and for plain inside stack show material improvement in draft values.

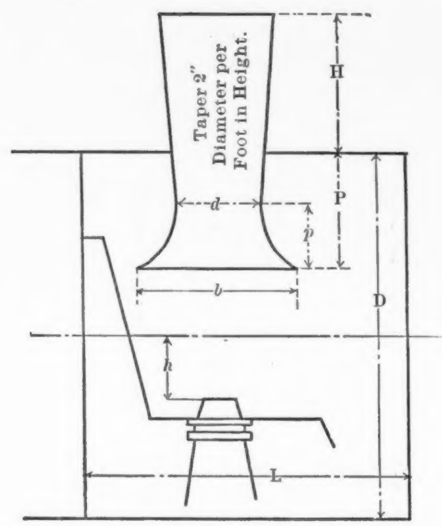
Substitutes for False Top.—The false top necessarily interferes with free access into the front-end, which fact makes it desirable that a way be found in which to secure the results derived from it by means which are more simple. It was suggested that experiments be made to determine the effect upon the plain inside stack of an annular ring or flange which might be considered as representing a portion of the false top. Responding to this suggestion, rings of two diameters were used on 17 and 19-in. stacks having a penetration of 24 ins. It was found that the proportions shown by Fig. 7 gave substantially the same results as those obtained with the best arrangement of false top. Believing that the results thus obtained pointed to the desirability of having a broader curve at the base of the stack, and that when the proper proportions were understood, the best results would be obtained from such a curved surface, the 17-in. stack was fitted with a bell, to which, for purposes of experimentation, flanges of various widths were afterward added, with the result that those proportions which appear in Fig. 8 proved most satisfactory. It will be noted that the best draft with the false top was 5.06; with the ring, 5.05, and with the bell, 4.98. That is, these three arrangements are practically on an equality. No other arrangements were experimented upon which gave higher draft values than these.

Single Draft-Pipes.—Draft-pipes of various diameters, adjusted to many different vertical positions, were tested in connection with plain stacks of the several diameters available. The elaboration of this phase of the work was very extensive. It was found that for the best results the presence of a draft-pipe requires a smaller stack than would be used without it, but that no possible combination of single draft-pipe and stack could be found which gave a better draft than could be obtained by the use of a properly proportioned stack without the draft-pipe. While the presence of a draft-pipe will improve the draft when the stack is small, it will not do so when the stack is sufficiently large to serve without it. The best proportion and adjustment of a single draft-pipe and stack are shown by Fig. 4.

Double Draft-Pipes.—Double draft-pipes of various diameters and lengths, and having many different positions within the front-end, all in combination with stacks of different diameters, were included in the experiments with results which justify a conclusion similar to that reached with reference to the single draft-pipe. Double draft-pipes make a small stack workable. They cannot serve to give a draft equal to that which may be obtained without them, provided the plain stack is suitably proportioned. The arrangements and proportions giving the best results are those shown by Fig. 5.

The Length of Front-End.—The experiments involving different lengths of front-end only appear to be inconclusive. The range of these experiments included the length of front-end normal to the locomotive, which is 65.75 in., with successive reductions therefrom of 4½, 8 7/16 and 20 ins. respectively, obtained in each case by fitting in a false-front. The fitting was well done, the work being made practically tight, notwithstanding which fact it was found that the longest and shortest ends experimented with gave practically identical results, while the lengths between these limits gave results which were somewhat inferior. The peculiar character of the results as first obtained led to a complete duplication of the work after a considerable interval had elapsed, with results which were identical with those first obtained. So far as the experimental results give a solution to this problem, they point to a length of 66 or 46 ins. as equally satisfactory and suggest that intermediate lengths are to be avoided.

A Suggestion as to a Standard Front-End is presented as Fig. 9, which, with the following equations referring thereto,



BEST ARRANGEMENT OF FRONT END

may be accepted as a summary of the conclusions to be drawn from all experiments made.

For best results, make H and h as great as practicable.

Also make, $d = .21D + .16h$
$b = 2d$ or $.5D$
$P = .32D$
$p = .22D$
$L =$ (not well established).
$=$ .6D or .9D but not of intermediate values.

While the drawing is a simple one, to be put forth as a result of so elaborate a series of experiments, it goes without saying that the latter have been valuable quite as much for the things they prove useless as for the proportions of details which they serve to define. For example, it will be seen that the suggested standard does not include draft-pipes, and that it includes a stack of comparatively large diameter having a bell as the lower end of dimensions quite beyond those now common in American practice.

Respectfully submitted,

H. H. Vaughan,
F. H. Clark,
Robert Quayle,
A. W. Gibbs,
W. F. M. Goss,
G. M. Basford,
Committee.

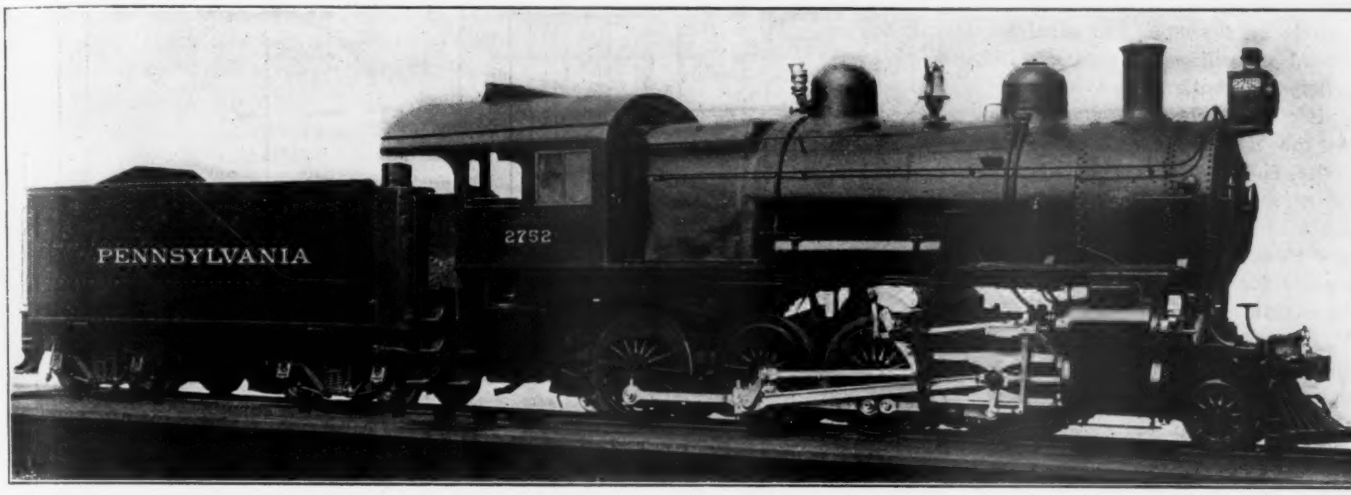
The American Society for Testing Materials.—The ninth annual meeting of this association will be held at Atlantic City, N. J., June 21 to 23.

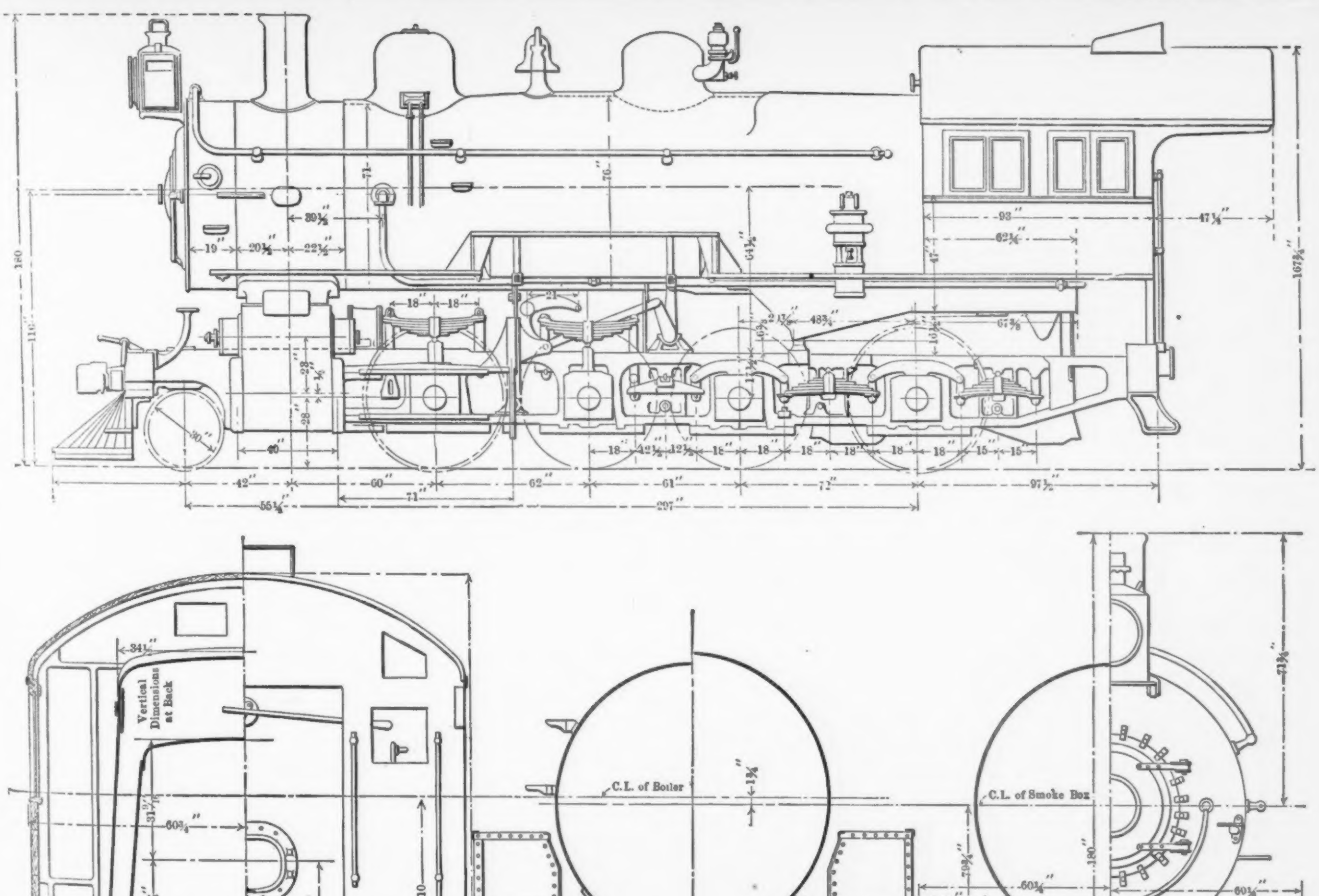
SIMPLE CONSOLIDATION LOCOMOTIVE WITH WALSCHAERT VALVE GEAR.

PENNSYLVANIA RAILROAD.

For a number of years the standard consolidation locomotive in use on the Pennsylvania Railroad has been a 22- by 28-in. simple engine with slide valves, 56-in. wheels, 70-in. Belpaire boiler, and weighing 194,200 lbs. This engine was titled Class H6A in the railroad company's classification, and one of this type was the first locomotive tested on the Pennsylvania Railroad's testing plant at St. Louis, where it gave a most satisfactory account of itself, as shown by the results published in the report of these tests issued by the company.

Recently, in considering an increase of this type of power, it was decided to apply the Walschaert valve gear and piston valves to the new engines, but in other respects to stick very closely to the dimensions and parts of H6A. An order of



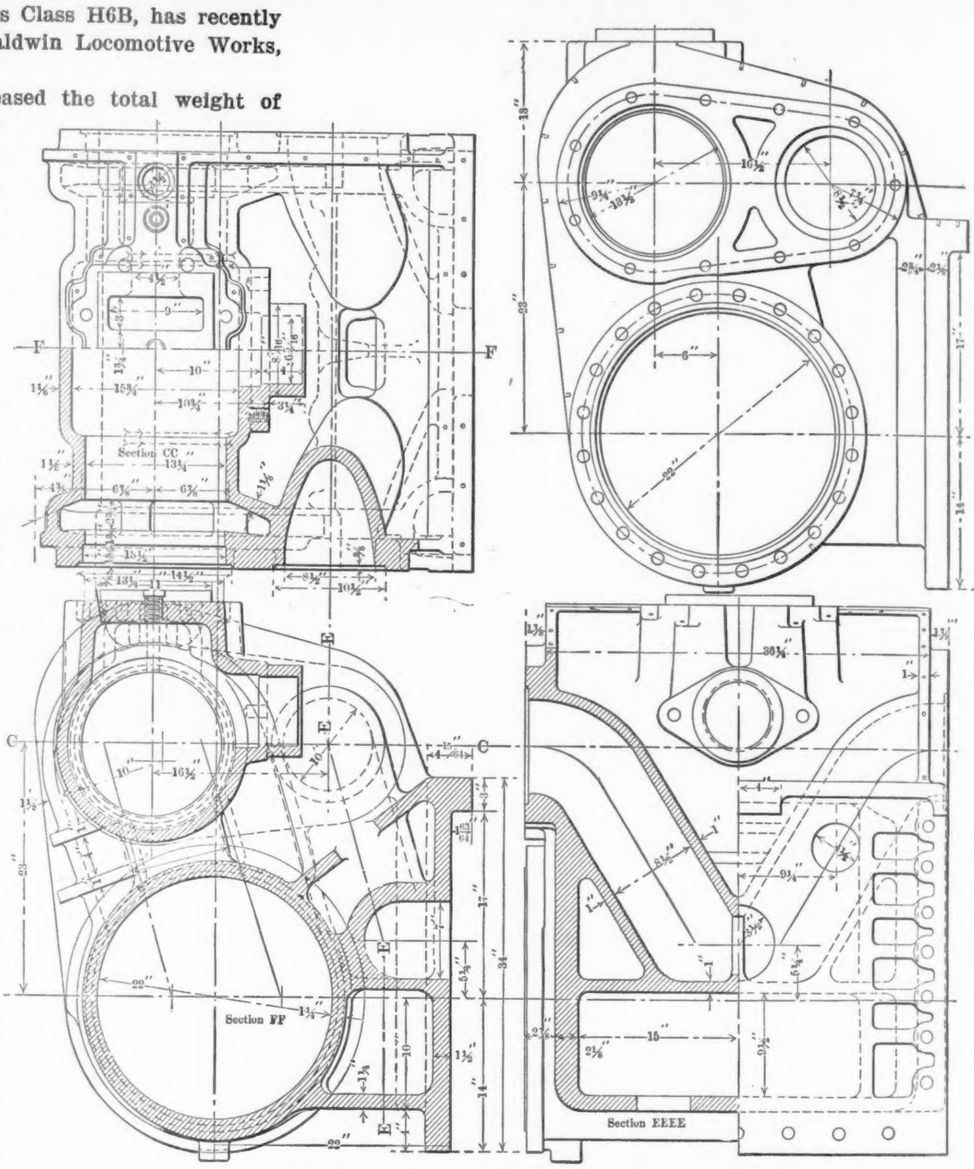


CONSOLIDATION LOCOMOTIVE, WITH WALSCHAERT VALVE GEAR.—PENNSYLVANIA RAILROAD.

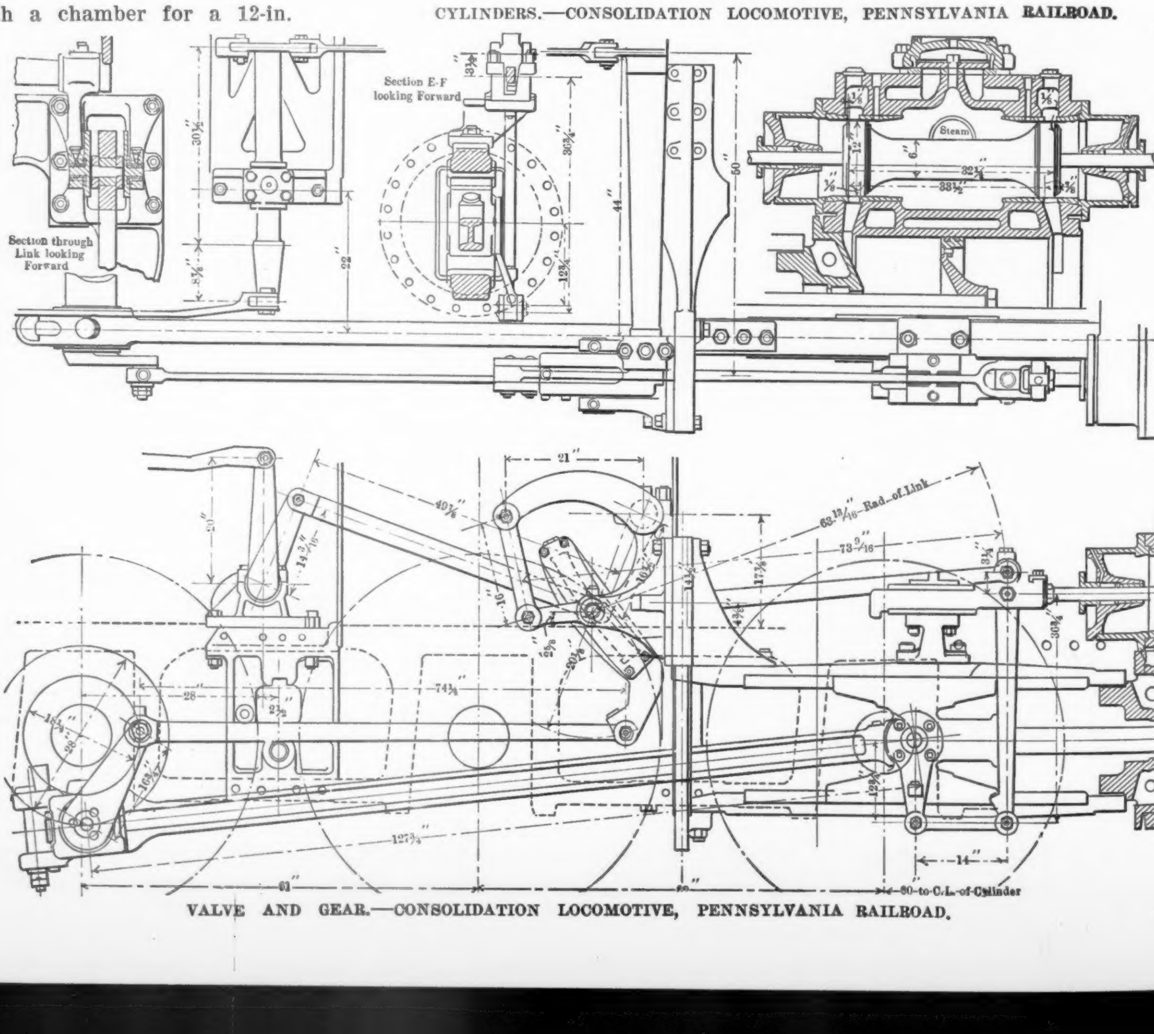
this newer type, which is known as Class H6B, has recently been built and delivered by the Baldwin Locomotive Works, and is illustrated herewith.

The change in design has increased the total weight of the engine somewhat, making this latter class weigh over 200,000 lbs., of which over 177,000 lbs. is on drivers. The tractive power figured at 85 per cent. boiler pressure is 42,200 lbs., which gives an adhesive ratio of 4.2. The engine as a whole is a simple and straightforward consolidation engine with a Belpaire boiler, and contains nothing particularly unusual outside the new features as applied to the H6B. The report of the locomotive tests at St. Louis contains a thorough description of the Class H6A, to which reference can be made for most of the details of this engine.

The new design of cylinders using piston valves contains a number of new and interesting features. As has been the custom for this type of power on this road they are cast with a separate saddle, a plate frame passing between the cylinders and the saddle, the whole construction being securely bolted together. The passage for live steam in the saddle opens above the frame connection and is continued by a short pipe with ground joints extending directly to the valve chamber. The exhaust passage, however, is in its usual place in the saddle casting, and an opening is cut in the plate frame connecting the passage from the cylinder casting. The cylinders are cast with a chamber for a 12-in.



CYLINDERS.—CONSOLIDATION LOCOMOTIVE, PENNSYLVANIA RAILROAD.



VALVE AND GEAR.—CONSOLIDATION LOCOMOTIVE, PENNSYLVANIA RAILROAD.

piston valve located above and 6 ins. outside the centers of the cylinders. The construction of this chamber is such that the steam ports into the cylinder are almost vertical and in itself it has no exhaust passage, this passage being formed in the heads, which are elongated and connect the end of the valve chamber with the opening forming the end of the cored exhaust passages, which is just inside of and on a line with the valve chamber.

The piston valve, which is somewhat longer than the stroke of the engine, has an extended valve rod which passes through the front head and is fastened at the rear to a small crosshead running in a guide bolted to the top guide bar. This crosshead has a connection to the combination lever of the Walschaert valve gear below the connection to the radius arm.

One of the governing features which led to the use of the Walschaert valve gear on this class was the fact that the removal of the eccentrics and motion work between the frames allowed space for the introduction of a more substantial and satisfactory frame bracing. In making the application of this gear it was necessary to considerably strengthen the guide yoke for carrying the large overhanging weight of the link and connections, and this has been done by making it of cast-steel in two sections, which are fastened to the frame and boiler brace as well as a heavy steel frame brace of open section which is placed between and stiffens all four bars of the frame. The reverse shaft has been left in its old location and has an upward extension arm in its centre which connects to the downwardly extending arm of the reverse shaft extending across beneath the boiler back of the guide yoke, to which the radius arms of the Walschaert gear are connected through hangers in the manner shown in the illustration.

The other features of this very powerful and well arranged locomotive will be made clear by reference to the illustrations and following table of dimensions:

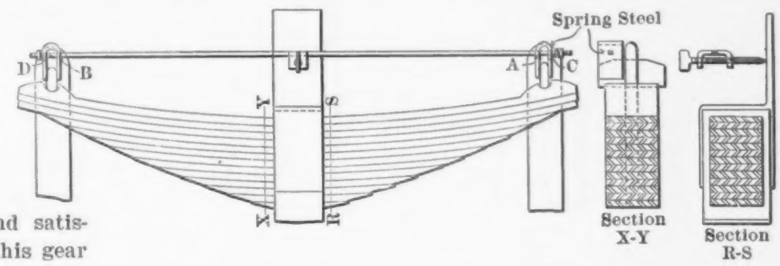
CONSOLIDATION LOCOMOTIVE. WALSCHAERT VALVE GEAR.

GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Service	Freight
Fuel	Bit. coal.
Tractive power	42,200 lbs.
Weight in working order	200,380 lbs.
Weight on drivers	177,320 lbs.
Weight on leading truck	23,060 lbs.
Weight of engine and tender in working order	332,000 lbs.
Wheel base, driving	16 ft. 3 ins.
Wheel base, total	24 ft. 9 ins.
Wheel base, engine and tender	55 ft. 2¾ ins.
RATIOS.	
Weight on drivers ÷ tractive effort	4.2
Total weight ÷ tractive effort	4.75
Tractive effort x diam. drivers ÷ heating surface	823
Total heating surface ÷ grate area	58.1
Firebox heating surface ÷ total heating surface	6.4%
Weight on drivers ÷ total heating surface	62
Total weight ÷ total heating surface	70
Volume both cylinders	12.3 cu. ft.
Total heating surface ÷ vol. cylinders	233
Grate area ÷ vol. cylinders	4
CYLINDERS.	
Kind	Simple
Diameter and stroke	22 x 28 ins.
Valves	Piston
Diameter	12 ins.
WHEELS.	
Driving, diameter over tires	56 ins.
Driving, thickness of tires	3 ins.
Driving journals, main, diameter and length	9 x 13 ins.
Driving journals, others, diameter and length	9 x 13 ins.
Engine truck wheels, diameter	30 ins.
Engine truck, journals	5½ x 10 ins.
BOILER.	
Style	Belpaire
Working pressure	205 ins.
Outside diameter of first ring	71 ins.
Firebox, length and width	107⅛ x 66 ins.
Firebox plates, thickness	5-16, ⅜, ½ in.
Firebox, water space	5 ins.
Tubes, number and outside diameter	373, 2-in.
Tubes, length	13 ft. 9½ ins.
Heating surface, tubes	2,677 sq. ft.
Heating surface, firebox	182 sq. ft.
Heating surface, total	2,859 sq. ft.
Grate area	49.11 sq. ft.
TENDER.	
Tank	Waterbottom
Frame	Steel
Wheels, diameter	33 ins.
Journals, diameter and length	5½ x 10 ins.
Water capacity	7,000 gals.
Coal capacity	14 tons

SEMI-ELLIPTIC SPRINGS FOR LOCOMOTIVES AND TENDERS.

BY WILLIAM H. MUSSEY.

The proper design of locomotive and tender springs is a very important factor in securing the best results from the heavy motive power which has come into use. They are in many cases made to fit the design of frame, boiler, etc., and even then are not always given the attention they should have. Several years ago the writer made a number of tests to



determine just what loads driving springs were subjected to in service. A recorder was made, as shown in the illustration, to register the deflections produced by service conditions. Ample play was allowed at C and D and a moving fit at A and B. The pointer was threaded and the tension on the plate was regulated, as desired, by hand. At times a check nut was placed on the pointer, bearing against the inverted U-shaped section of the rod, to guard against its screwing in or out.

With the recorder in place and the engine on a level track, a horizontal line was drawn to designate the static load. The springs had all been tested, before being applied, both for free height (set), static working load and a test load, so that the loads corresponding to the various heights were known. The horizontal line, which was used as a basis for the test, was found to check closely with the height obtained for the static working load by the manufacturer. The marks made on the plate, which was chalked, by the pointer gave the maximum and minimum deflections due to service conditions. From these deflections, which were measured from the base line, previously established, the corresponding actual loads were determined. The greatest value for the live load was found to be about 65 per cent. above the static working load, and the minimum 45 per cent. less than the static working load. These figures were obtained from a number of engines on which the spring rigging was considered satisfactory, and were obtained at cross-overs, switches and moving on and off turn-tables, thus representing very severe conditions.

Having gained an insight into the service demands, it was possible to more readily decide on the necessary requirements for a satisfactory spring. Introducing an arbitrary factor of safety, it was decided that in designing springs the plates should come within 3-16 in. of the horizontal for a load equivalent to twice the static working load, whenever it was possible with the conditions imposed by the locomotive construction; also that the fibre stress at this point should not exceed 130,000 lbs. per sq. in. The 3-16 in. is the construction variation allowed the manufacturers by many specifications, which state that heights for given loads must not vary more than 3-16 in. above or below those specified. With the utmost permissible variation, therefore, the plates will not pass the horizontal for a load equal to twice the static working load. The 3-16-in. allowance is entirely arbitrary, and has no relation to the total deflection of the spring, as it should. However, it is satisfactory to the manufacturer and also the railroad, and in no case in a well-designed locomotive spring have we found this allowance excessive.

By watching closely the life and service conditions of springs it was found that a good figure for the fibre stress per square inch under the static working load was between 60,000 and 65,000 lbs.; 70,000 lbs. is permissible, but 75,000

lbs. is too high, and limits the life of the spring. This latter figure means that for a possible live load the stress goes above 120,000 lbs. per sq. in., and repeated strains at that figure should be avoided with the average open-hearth steel. Our experience with springs has proved this conclusively. We specify a test load height, and fix this load so it produces a fibre stress of about 120,000 lbs. per sq. in. This is a precaution to insure a high-grade spring. The stress of 130,000 lbs. per sq. in. we might call our ultimate figure; we don't expect springs (open-hearth steel) to stand loads exceeding this even at rare intervals.

These springs are designed by the Reauleaux formulæ for semi-elliptic springs:

$$P = \text{(static load on one end)} = \frac{Snbh^2}{6L}$$

$L = \frac{1}{2}$ span in inches less $\frac{1}{4}$ width of band.
S = fibre stress per sq. in.
b = width of plate in inches.
h = thickness of plate in inches.
n = number of plates.

FOR DEFLECTIONS.

$$D = \frac{6PL^3}{Enbh^3}$$

Equating for value of P.

$$D = \frac{SL^2}{Eh^2}$$

E = modulus of elasticity = 29,400,000.

There may be some question about the deduction from L of one-quarter the width of the band, but this is theoretically correct as a study of the action of the leaves of a spring will show. Springs designed on this basis will be guaranteed by the spring manufacturers for one year's service, and in practice they far exceed it. Springs so designed are still in service at the end of two years and show no signs of failure, and we confidently expect a continued satisfactory service for some time to come. The lower the fibre stress the longer the life of the spring within reasonable limits. To indicate the severe service that these springs are subjected to, it might be added that they are used on a road which has very little stone ballast.

In designing springs it should be the aim as nearly as possible to have equal deflections under the working loads for those springs which are equalized together. When possible short springs should be avoided and also narrow ones. Long springs with wide plates give the most even deflections, taking up shocks more effectively. On short springs, 24, 26 or 28-in. spans, it is better to use thin plates ¼ to 5-16 in. thick. As the length of span increases the thickness of plate should also be increased; for a 48-in. span ⅜-in. or even 11-16-in. leaves are not excessive. In one case a spring with a span of 26 ins. and ⅜-in. leaves was equalized with a spring having a 38-in. span and 7-16-in. plates and gave poor service, although the fibre stress was comparatively low. By reducing the thickness of the plates and with about the same fibre stress much better results were obtained. The aim is to increase the deflections for given loads on short springs, where it is naturally small, and to decrease them on long springs, where it is, on the other hand, excessive. By examining the formula for deflections $D = \frac{SL^2}{Eh^2}$ we find that deflections for a given load vary directly as the square of L, and inversely as the square of the thickness. From this the relation that thickness bears to the length is apparent.

Good practice is to keep the deflection from the free height to the static working load between 1½ and 2¼ ins. where possible. The former figure covers short springs, the latter longer ones; conditions, however, do not always permit this. The width of the bands should be about one-tenth the span of the spring. All of the foregoing applies more especially to driving springs. For engine truck and tender truck springs the service conditions are not as exacting. The springs may be stiffer, the fibre stress decreased and the life of the spring thus increased; in no case, however, is the use of leaves over 11-16 in. thick recommended. To reduce the fibre stress it is better to use wider plates, if possible, even though clearances require them to be reduced in width at the hanger.

FORGING AT THE COLLINWOOD SHOPS.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

On page 143 of our April issue we illustrated and described a number of forgings which are being manufactured in the forging and bulldozing machines and under a Bradley hammer at the Collinwood shops of the Lake Shore & Michigan Southern Railway. The value of these machines depends entirely on their being properly equipped with special tools and dies for the different parts to be manufactured, and if these are provided the rate at which forgings can be turned out is usually limited only by the facilities for heating the iron. Not only is it thus possible to greatly increase the output of the shop, but the grade of work turned out is superior to that done by other methods. In this article, which supplements the earlier one, the dies and formers for making several of the more intricate forgings are illustrated.

FIG. 1.—GENERAL VIEW OF THE MANUFACTURING SECTION OF THE COLLINWOOD SMITH SHOP.

One of the illustrations shows a general view of the manufacturing section of the smith shop. In the foreground, to the right, is a No. 3½ Ajax forging machine, the largest forging machine used in the shop. Just to the rear of it is a No. 6 and also a No. 8 Williams and White bulldozer. The No. 8 machine is served by a jib crane, so that the heavy cast-iron formers can readily be transferred from the storage platform, indistinctly shown in the background, to the machine. At the right and just opposite the No. 6 bulldozer is a large punch and shear. A 200-lb. Bradley hammer, to the left and

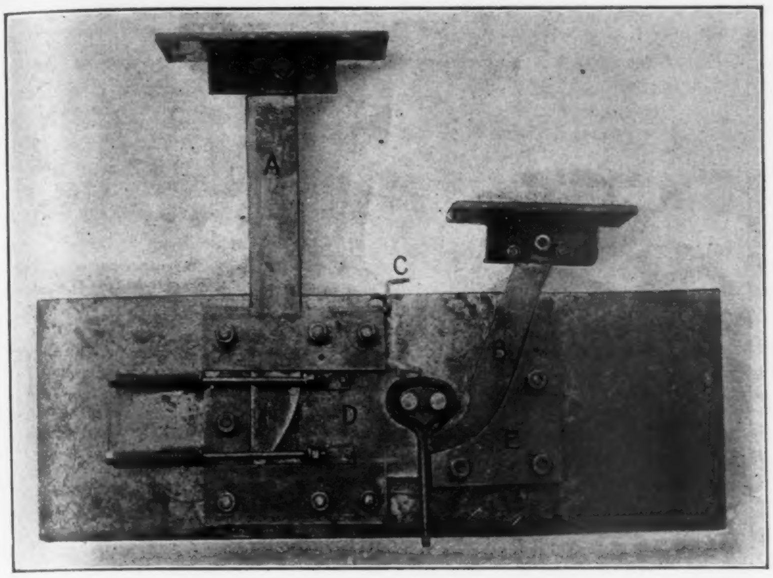


FIG. 2.

not shown in this view, is also used to considerable advantage in connection with the manufacturing work. In the foreground may be seen a number of truss rod anchors, safety chain hooks in the first stage of manufacture, baggage car carlines and coupler pockets in various stages, which are made by these machines.

Fig. 2 shows a device which was built at the Collinwood shops, and is used on the bulldozer for forming the handles of ash hoes and hooks. These handles are formed and completed cold. As it is possible to make one complete handle for every stroke of the machine, without heating the iron, a considerable saving has been effected over former methods. The photograph does not, of course, show the relative position of the wedge and cam when the machine is in operation, but the operation of the device can readily be understood from the following description. The wedge A and the cam B are fastened to the face plate of the bulldozer by means of the brackets shown at their upper ends. A straight bar of iron is placed against the stop C. As the crosshead of the bulldozer advances the wedge A forces the head D forward, completing the first half of the handle, and leaving the end at right angles to the original bar. At this point the cam B comes in contact with the guide E, forcing the end of the handle to the position shown and completing it.

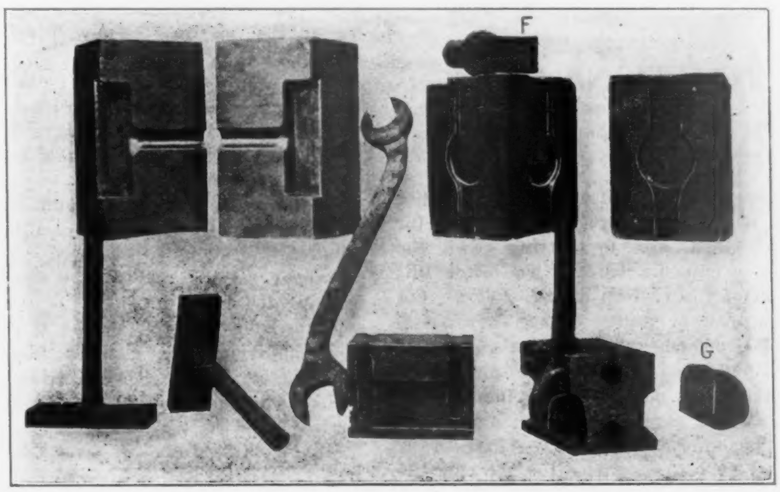


FIG. 3.

Fig. 3 shows a back flue sheet brace similar to the ones which are being manufactured in the forging machine. The end of a piece of ¾ by 2½-in. iron is first swaged under the Bradley hammer forming the round bar. A hole is then punched in the rectangular piece which forms the foot and the round bar is entered, heated to a welding heat, and is formed in the forging machine, in the dies shown in the upper left-hand corner. This method is very much more satisfactory than that of drawing the brace out from the solid, and produces a better brace.

At the right, in this view, are shown the tools for forming wrenches in the forging machine from round steel bar. In the first operation the end of the bar is placed between the two upper dies and flattened, and is formed into a blank by the plunger F. In the second operation the blank is placed in the lower dies, and the opening is punched to the proper size by the punch G. The center of the wrench is then flattened out under the Bradley hammer and is bent to the finished shape as shown.

Fig. 4 shows at the right a driver brake adjusting rod, which is finished complete in the forging machine. A rectangular head is first formed on the end of the round bar of iron. A plain piece is sheared from a rectangular bar for the opposite end. Two pieces of 2½ by ¾-in. iron are then clamped on the rectangular head of the stem end, are heated to a welding heat, placed in the dies shown in the upper right-hand corner, and the ram H is forced over the bar or stem, making a complete weld in one operation. The dies are then reversed, the crosshead is placed in position, and the blank end is inserted between the two forks, heated to a welding heat, and the ram I is forced against the blank block while it is gripped in the jaws, punching a hole and welding complete in one operation. With this arrangement a saving of 70 per cent. is effected over hand forging and a better forging is obtained.

At the left are shown the dies and plungers for forming the brake rod for the standard four-wheel steel passenger trucks. This connecting rod is 5 ft. long with a fork at each end. It is made of 2½-in. double, extra strong wrought iron pipe. A piece of round iron is placed in the end of the pipe, heated to a welding heat, and the square is formed in the dies, shown above, with a blank plunger, which is not shown. The opening is then sheared out with the ram J and completed with the former K, which shapes the end and regulates the width and thickness, form-

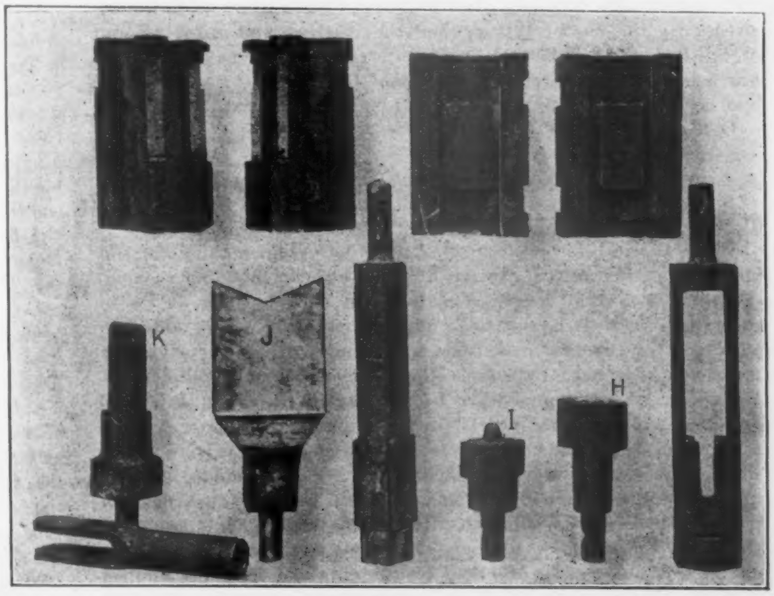


FIG. 4.

ing the completed end as shown. This operation has effected a saving on the piece work prices of 75 per cent. over the hand method of making these rods.

At the right in Fig. 5 are shown the dies and the method of forming the yoke for raising and lowering the water scoop dippers on tenders. M shows the blank after it has been punched by the ram N and the dies, shown at the right. O shows the lugs, which are punched from bar stock, cold. Both lugs are placed in the blank M, heated to a welding heat and welded on a hand block in the forging machine, using a plain rectangular ram, which is not shown. As will be noted, the attachment of the lugs to the bar is very neatly made.

At the left are shown the dies for forming the standard connection, P, for the expansion sling stays. These are formed from $1\frac{1}{8}$ by $2\frac{1}{2}$-in. iron. The end is first pinched in the dies preparatory to forming the round base. The bar is then moved forward the proper distance, and as the dies come together the end is sheared off, as will readily be understood by referring to the photographs of the dies. It is held in the pocket while the ram Q comes forward compressing the stock and forming the hole which is threaded to receive the crown bolt. This is formed in one heat and one operation. We are indebted for information to Mr. M. D. Franey, superintendent of the Collinwood shops.

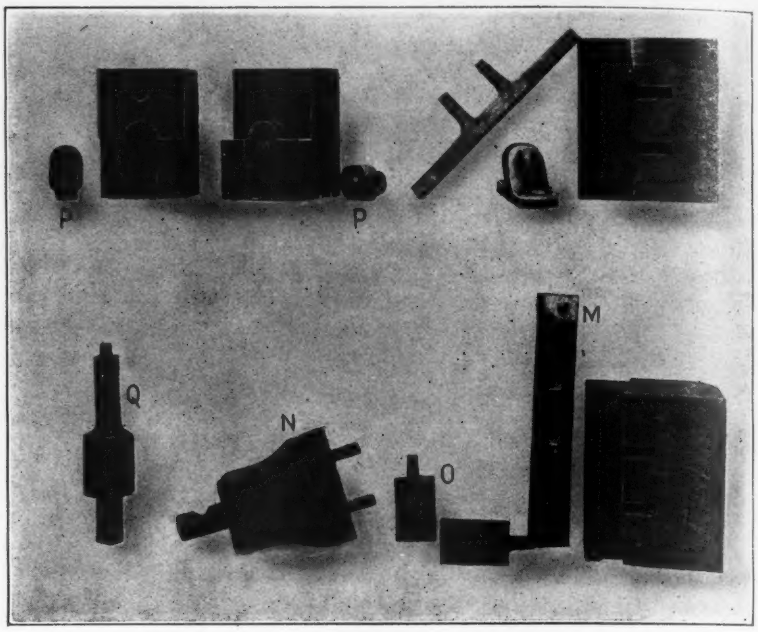


FIG. 5.

COMMUNICATIONS.

FINISH ON PATTERNS.

To the Editor:

Considerable improvement may be made over general practice by railroad companies in the matter of constructing patterns for castings more nearly to the desired size by cutting down the amount of "finish" allowed on machined surfaces. Too often this matter is left to the discretion of the pattern maker, and he, not knowing the exact requirements of, or degree of accuracy necessary on the part in hand, adds from one-sixteenth to a quarter of an inch finish, as he sees fit. It seems best that the amount of finish a piece is to have should be decided by the engineering department, where all conditions as to requirements of the part are known. *Where* parts should be finished should be marked as well as the *amount* of finish. Few better systems for marking the amount of finish on drawings are in use than the following: Surfaces requiring one-thirty-second of an inch finish, mark thus $\frac{1}{F}$; those requiring one-sixteenth of an inch, $\frac{2}{F}$; those requiring three-thirty-seconds of an inch, $\frac{3}{F}$; etc. The figure placed above the "F" denotes the number of thirty-seconds thickness of finish desired. By the use of this method the location and exact amount of finish may be indicated on the drawing, and if pattern-makers are held to this, the excess metal can be reduced to a minimum, and no small item of expense saved, both in material and labor.

Detroit, Mich. J. C. AUSTIN.

THE FOUR-CYLINDER BALANCED COMPOUND.

To the Editor:

While the results of the tests of the four-cylinder balanced compound locomotives at St. Louis indicated an efficiency and economy of this type over all others, a majority of motive power men seem to hesitate in their acceptance of the facts before a very long consideration of the new conditions to be met with in operation and maintenance in actual service. Imaginary "compound" difficulties, twisted crank axles and other bogies seem to threaten them with an increased "cost per mile," and a prejudice is apparently created which as yet the engines have had no chance to earn!

The objections, however, in some cases are well founded on some unsuccessful and costly experiments with certain types of compounds which were wholly unsuited to the conditions surrounding them and the services required. This may account for the apparent lack of interest in practical results obtained from the application of what is conceded to be an excellent principle. Notwithstanding the fact that a great many roads have been experimenting with some particular type of four-cylinder balanced compound, there has been very little written upon this important subject bearing on the relative economy or efficiency of these engines in regular service.

There would seem to be a great deal of significance attached to the fact that the Oregon Railroad & Navigation Company, after several months' trial of a heavy Pacific type balanced compound in passenger service, has ordered a lot of simple engines of nearly the same specifications.

On the other hand, the Santa Fe, a road which operates under the most widely diversified conditions known, has more than a hundred four-cylinder balanced compounds in the most exacting passenger service, and each succeeding locomotive order includes more of the latter type.

The writer believes that he is only one of a great many who would appreciate some light on this very interesting and timely subject, whether it be a general review and criticism or simply a comparison of results from the operation of these engines in regular service.

Minneapolis, Minn. J. P. R.

RIEGEL WATER TUBE BOILER.

To the Editor:

Referring to the criticisms of the water tube boiler in your May issue. In view of the exceptions taken in the communications to the circulating baffling sheet, placed 30 ins. ahead of the tube sheet of the boiler, as illustrated in your April issue, perhaps a little explanation setting forth the reasons for its introduction would put more light on the subject.

To begin with, the baffling sheet is not a necessity, nor really a part of this design in particular. It was introduced into the design to overcome flue leakage in rear tube sheet. There are those who believe flue troubles are due to the furnace flames impinging directly against the flue ends, causing them to become highly heated and consequently expanded, which, when quickly cooled by an inrush of cold water, causes a rapid contraction of the firebox ends of the tubes submerged in the cold currents and makes them leak. By the introduction of the extra firebox surface in the new design the flue surface can be reduced; thus be kept away from the barrel; a smaller number of flues, with a wider bridge, being justified. The dam sheet is proposed to be used under these conditions. It will be noted, in the description it is stated "the necessary flue holes in this dam are not a tight fit to the flues," i. e., the holes are to be sufficiently large to allow a moderate amount of water to flow through all of the flue holes between the flues and the sheet. The object of the plate being to baffle or retard the cold currents and keep them away from the flue ends until they can become warmed above the danger point. With the water tube arrangement the circulation about the firebox will be so vigorous as to excite all of the water to circulation. As the head creating the circulation will be the upward currents through the water tubes, which, in the design, is due to the heat effect on a

surface of 538 sq. ft. against the balance of 230 sq ft. of firebox surface, or approximately a pull of 538 units against a resistance of 230 units. This has a tendency to draw the water from the water legs and the barrel of the boiler into the water pockets. The water would have to both flow over and leak through the dam sheet. The forward part would thus provide a thermal storage chamber within the boiler itself.

Incrustation of the water tubes of course depends upon the water used, but it is not as much as might be inferred by some. From actual service records of engines with cross-water tubes on the London & Southwestern Railway, England, from a water, on a greater part of the system, having a total hardness of 16 grams per gallon, yielding a very heavy deposit, the tubes are only cleaned when the engines come to the shops for general repairs at intervals of eighteen months or so. In this time the mean deposit does not exceed 1/32 in.

The average life of a tube depends upon its position in the group. Those in the outside rows in express engines built between 1899 and 1901 have a life varying from two and a half to five years, the short period being due to manufacturers' defects developing.

S. S. RIEGEL,
Southern Railway Company.

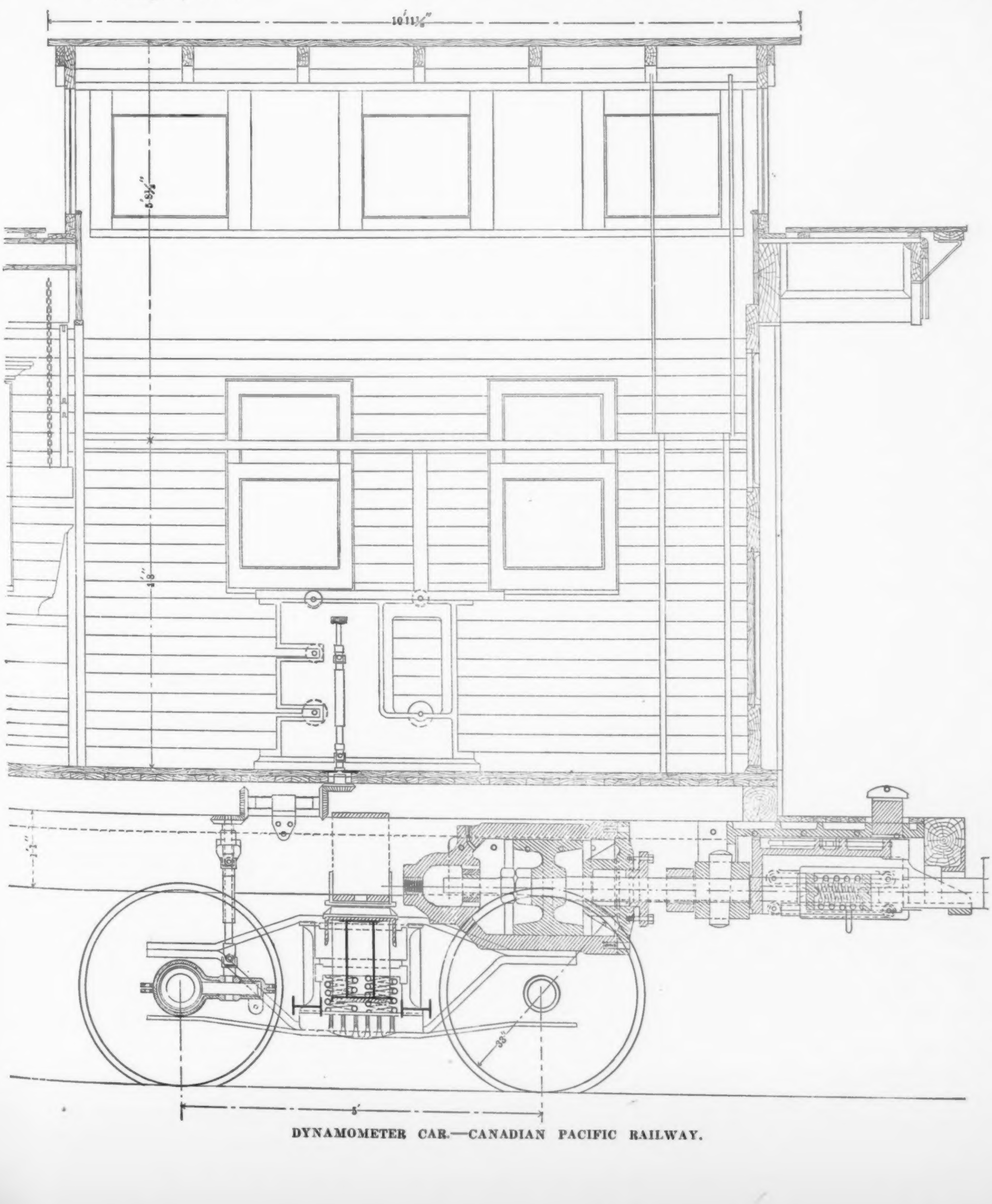
1300 Pennsylvania Avenue,
Washington, D. C.

DYNAMOMETER CAR.

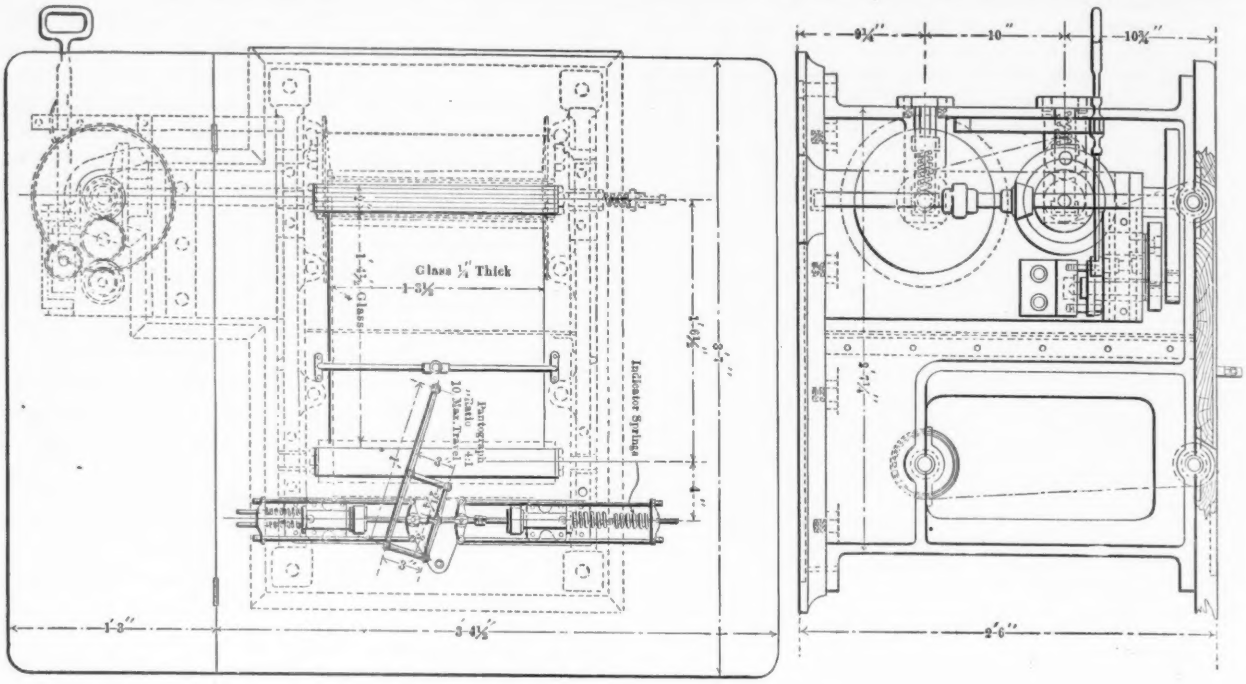
CANADIAN PACIFIC RAILWAY.

The Canadian Pacific Railway has recently built a dynamometer car at the Angus shops which is of special interest because of the arrangement for transmitting force from the drawbar to the hydraulic cylinder, and also because of the method of operating the recording pen. The construction of the car, except for the underframing, is similar to the standard caboose used on this road. The center sills are 13-in. channels, 37 lbs. per ft., spaced 26 ins. apart. Above each channel and between it and the floor is a 4⅛-in. wooden sill 6 ins. deep. The intermediate and side sills are 5 by 9 ins. The inside dimensions of the car are: length, 28 ft. 6⅜ ins.; width, 8 ft. 6⅜ ins. In addition to the space 10 ft. long at one end of the car, which contains the dynamometer table, there are two sets of upper and lower berths, a kitchen, pantry, clothes closet, heater room and saloon. The rear end of the car is equipped with Miner tandem spring draft rigging.

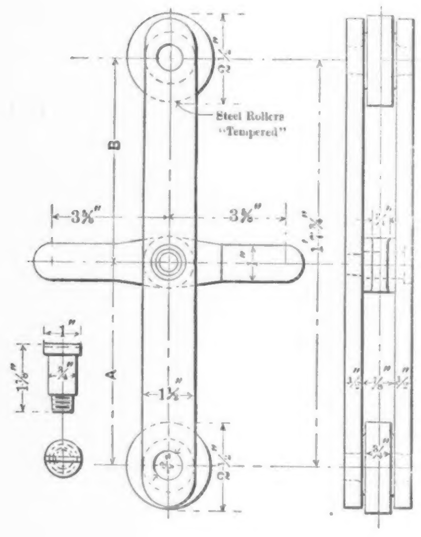
The drawbar at the dynamometer end of the car is of the



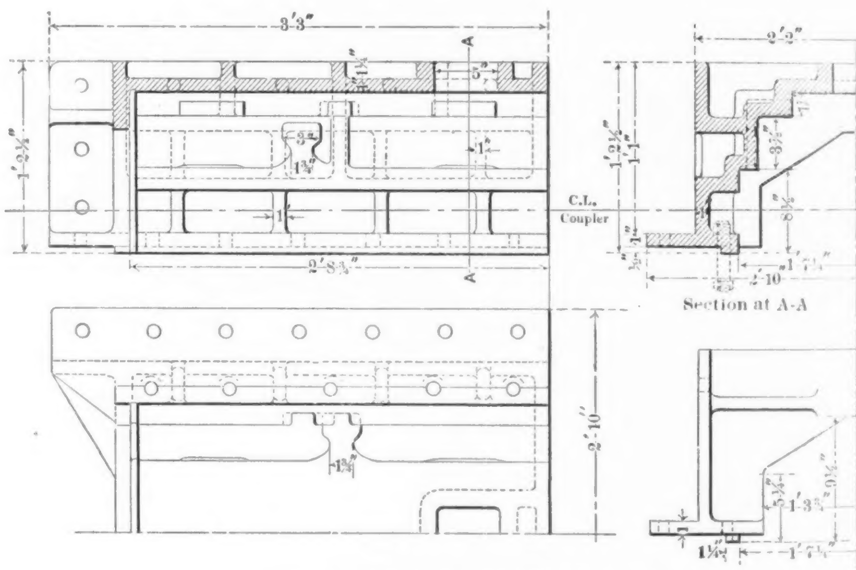
DYNAMOMETER CAR.—CANADIAN PACIFIC RAILWAY.



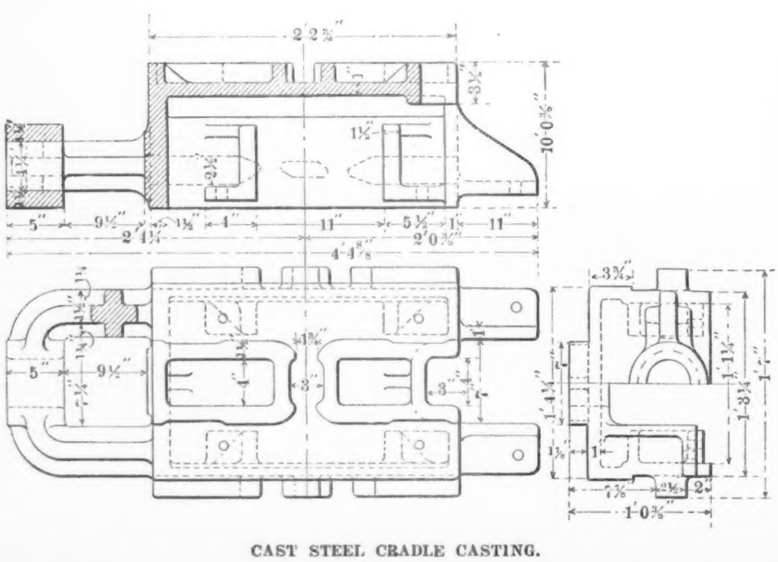
RECORDING MECHANISM.—DYNAMOMETER CAR.



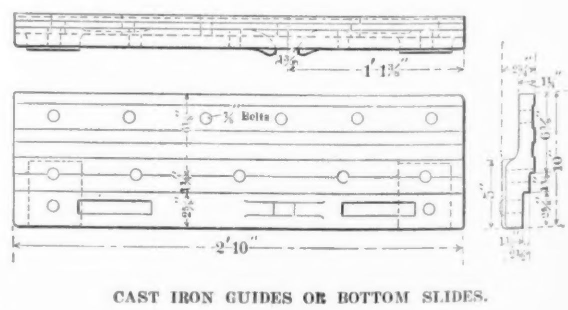
ROLLER BEARINGS FOR CRADLE.



STEEL CASTING IN WHICH CRADLE SLIDES.



CAST STEEL CRADLE CASTING.



CAST IRON GUIDES OR BOTTOM SLIDES.

standard type, and is equipped with an ordinary twin spring draft rigging. The follower plates of the draft rigging fit between lugs on a cast steel cradle casting, which is shown in detail in one of the illustrations. The cradle casting is connected to the dynamometer piston rod and slides in a heavy steel casting, which is securely bolted to the center sills. To reduce the friction to a minimum six roller bearings, of the Susemihl type, are interposed between the two castings, as

shown on the general drawing. Cast iron guides, or bottom slides, are bolted to the large steel casting and support the cradle casting at the bottom. At the rear end of the cradle casting is a heavy loop or projection. The dynamometer piston rod, 4 ins. in diameter, passes through a 4¼-in. hole in this projection, and is held in place by a large collar, to which it is keyed as shown in the drawing. The coupler carrier iron is bolted to two projections at the other end of the cradle casting. At any time that it is advisable to relieve the pressure on the dynamometer cylinder it is only necessary to force the oil out of the rear end and push the cradle casting back until it comes in contact with the rear end of the large casting, in which it slides, and drop into place the key which is shown projecting above the platform. The cradle will then be held rigidly and the draft rigging will operate the same as on an ordinary car.

The hydraulic cylinder is 16 ins. inside diameter and the walls are 2¾ ins. thick. It is bolted to the center sill by 20 one-inch bolts. The piston and cylinder are designed for a working pressure of 500 lbs. per sq. in. Each end of the cylinder is connected to the cylinders of the recording mechanism by ⅜-in. wrought iron pipe. A hand pump is provided to adjust the piston if it should get out of its central position.

Motion is transmitted from the axle to the paper driving mechanism by means of a worm, which is clamped to the axle and drives a worm wheel connected by the flexible shaft to a train of bevel and spur gears. By means of a lever at one corner of the table the paper may be operated at any one of three speeds, 6, 12, and 60 ins. per mile. The frame of the table is of a heavy cast iron design, making it very rigid.

The pen has a maximum travel of 10 ins., 5 ins. either side of the center line, and is controlled by a pantagraph motion with a ratio of 4 to 1. For registering the drawbar tension the pen is adjusted for 10,000 lbs. per in. As these stresses are the smaller and more important ones, the indicator springs are placed in tandem, as shown, so that with an ordinary drawbar pull the pen has a considerable movement. For the buffing strains, which are ordinarily very much higher, and which need not be registered so accurately, a twin arrangement of indicator springs is used, as shown. This car was designed under the direction of Mr. H. H. Vaughan, assistant to the vice-president, by Mr. A. W. Horsey, mechanical engineer.

RAILROAD Y. M. C. A.—A new Railroad Y. M. C. A. building, which cost $32,000, was opened at Collinwood, Ohio, L. S. & M. S. Ry., on May 1. Mr. W. C. Brown, vice-president of the New York Central Lines, at the close of an interesting address at the opening exercises, made the following statement: "The railroad which annually draws thousands of young men from the villages and farms to fill up its ranks, depleted by age, accident and disease, owes something to this army of young men. They owe it to the men themselves; they owe it to anxious, loving fathers and mothers back in the homes from whence these young men came; above all, they owe it to the public who daily place in the care and custody of these men their lives and property, to do everything within their power to make them the best, safest, most efficient men possible; and in doing this, in my opinion, no agency can be enlisted so adapted, so consecrated, so devoted to the work, and so successful in the work, as the railroad branch of the Young Men's Christian Association."

THREE-CYLINDER BALANCED COMPOUND LOCOMOTIVE.—For steam locomotives the merits of a three-cylinder balanced compound type, with one high-pressure inclined cylinder between the frames and a low-pressure cylinder at each side outside the frames; having the high and low-pressure cylinders connected by ordinary pistons, crossheads and main rods with the main driver axles and wheels, with cranks at 120 deg., and using a combined receiver and intermediate superheater for the passage of the exhaust steam between the high and low-pressure cylinders, should be investigated for passenger and fast freight service.—*Mr. Muhlfeld, New York Railroad Club.*

TEST OF THE WESTINGHOUSE CROSS COMPOUND AIR PUMP.

The continually increasing demands upon locomotive air pumps are apparent to all railroad men and have on larger locomotives, both passenger and freight, reached a stage where the pump is in almost constant operation with results which show not only in air-pump failures and repairs, but also have an appreciable effect upon the coal pile. In the past, features connected with capacity, weight and size of air pumps have been considered to be of greater importance than economy of operation and the improvements have all been along those lines.

Recognizing that the development of these devices has reached a stage where, while the previous considerations still deserve most careful study, the matter of economy of operation must also be included, the Westinghouse Air Brake Company has recently perfected a cross compound locomotive air pump which uses steam in compound cylinders connected to compound cylinders for the compression of air. While this arrangement doubles the number of cylinders over the previous designs built by this company, and occupies considerable more space as well as giving an increase in weight, recent careful tests of the pump show that its largely increased economy more than makes up for all of these disadvantages. The present design of this new pump uses an 8½ by 12-in. high-pressure steam cylinder located above and connecting to a 14½ by 12-in. low-pressure air cylinder. The low-pressure steam cylinder, which is 14½ by 12, connects to a 9 by 12 high-pressure air cylinder. The whole device is made as compact as possible, and considering its capacity it occupies but little more room than the simple pump.

In order to determine exactly what this new design would accomplish, a most careful test of it was made in comparison with what was considered to be the most efficient air pump at present on the market. This test was made under conditions which allowed accurate observations to be taken and gave results which are most gratifying from every standpoint. The series of tests made were all for the purpose of determining the efficiency and capacity and were made under several different conditions, first with the pumps working against a constant air pressure with different steam pressures; second, with the pumps working against constantly increasing air pressure, and third, with the pumps working against an orifice in a diaphragm at an approximately constant pressure. The table below gives some of the more interesting results obtained, which in all cases are a large improvement over the work of any locomotive air pump previously designed. A complete report of the test which was made under the direction of the motive power officials of the Lake Shore & Michigan Southern Railway at the Collinwood shops may be obtained from the Westinghouse Air Brake Company, Pittsburg, Pa.

AGAINST A CONSTANT AIR PRESSURE.

Steam pressure	200	200	200	200
Constant air pressure	140	130	100	70
Duration of test (min. and sec.)	5-46.4	4-41.8	4-07.6	3-11
Cubic feet free air pumped per min	115.5	131	151.6	168
Steam per 100 cu. ft. free air—lbs.	21.5	19.7	18.6	17.7
Volumetric efficiency, per cent	82.1	88.2	89.7	90.7

AGAINST A CONSTANTLY INCREASING PRESSURE.

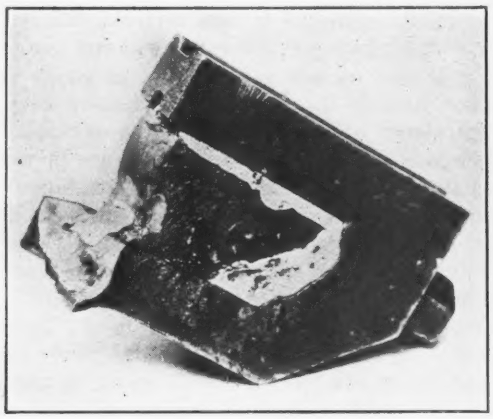
Steam pressure	200	200	200	200
Initial air pressure	30	30	30	30
Final air pressure	70	100	130	140
Cubic feet free air pumped	98.9	173.1	247.3	272
Weight of steam used, lbs	21	36.3	51.8	57.5
Time (min. and sec.)	0-39.8	1-12.4	1-47.6	1-59.2
Per 100 cu. ft. F. A. from initial to final pressure. Time, sec.	40.2	41.8	43.5	43.8
Per 100 cu. ft. F. A. from initial to final pressure. Steam, lbs.	21.2	20.9	20.9	21.1

The pump also held an average pressure of 119 lbs., with 200 lbs. steam pressure, against a 17/64-in. orifice for 2 minutes, using 25.6 lbs. of steam per minute.

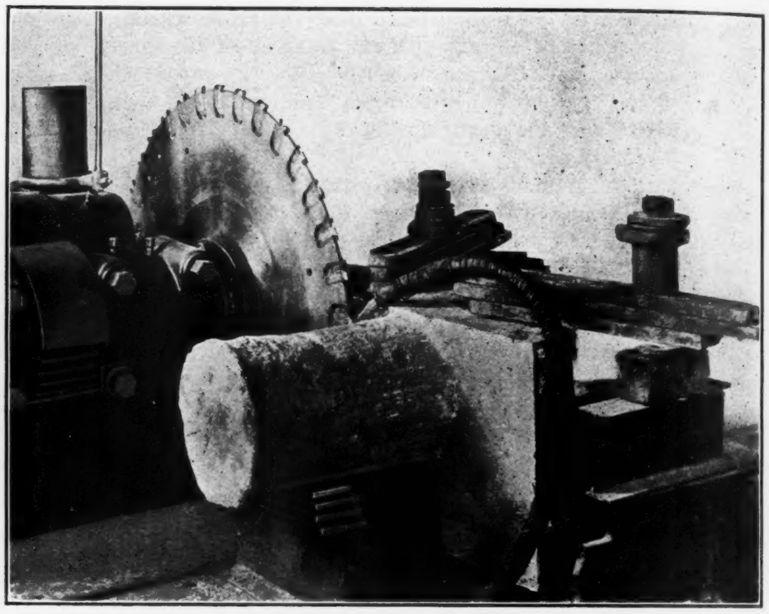
In the temperature test it held a pressure of 100 lbs. for 20 minutes, giving temperatures at the pump discharge gradually increasing from 340 degs. at the start to 505 at the finish, and in the reservoir of 210 degs. at the start and 280 at the finish.

THE TAYLOR NEWBOLD SAW.

The Taylor-Newbold saw has been developed during the past few years to meet the demand for a high-speed metal saw with a maximum cutting strength and a maximum resistance to abrasion. As may be seen from the illustrations, it consists of a heavy steel disc fitted at the periphery with a number of high-speed tools similar in shape to those used on a planer or lathe. It is thus possible to use a comparatively heavy feed, and the chips resemble those produced by a machine tool rather than the fine cuttings or dust produced by the ordinary type of metal saw. The total amount of power required to cut through a given piece of material is thus reduced, and there is very much less tendency to wear the teeth. The saw is specially valuable for cutting castings, as the depth of the cut is such that the teeth get under the scale or the hard surface, and are not ground away by the grit or sand, as is the case when a finer feed is used. The inserted teeth are so designed that they may be broken repeatedly without damage to the saw disc, and a broken tooth can be replaced easily and quickly without removing the blade from the machine.

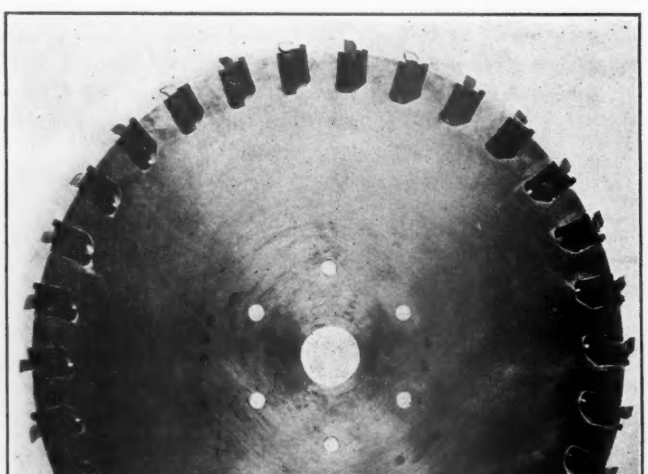


A BROKEN TOOL OR TOOTH.



CUTTING A HEAVY RISER ON A STEEL CASTING.

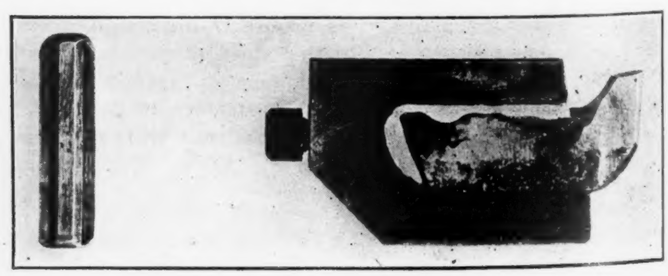
The steel disc is somewhat thicker than an ordinary saw blade, and has an even number of pockets milled about the circumference. These pockets are provided with tongues to hold the inserted teeth laterally, and the bottoms of the pockets are very accurately milled to the same distance from the center of the saw. The teeth consist of U-shaped holders, in which the cutters are inserted and held by casting type metal about them in such a way that each cutter has a solid steel bearing behind it, while the space in front, which is subjected to the least pressure, is filled with the soft metal. The holders are provided with set screws, by which the height of the cutters may be adjusted. At the back of each holder a wedge is driven to hold it securely in place. The teeth are alternately broad and narrow, the narrower teeth being set out further than the wide ones, so as to divide the cutting about evenly between the two sets.



THE TAYLOR-NEWBOLD SAW.

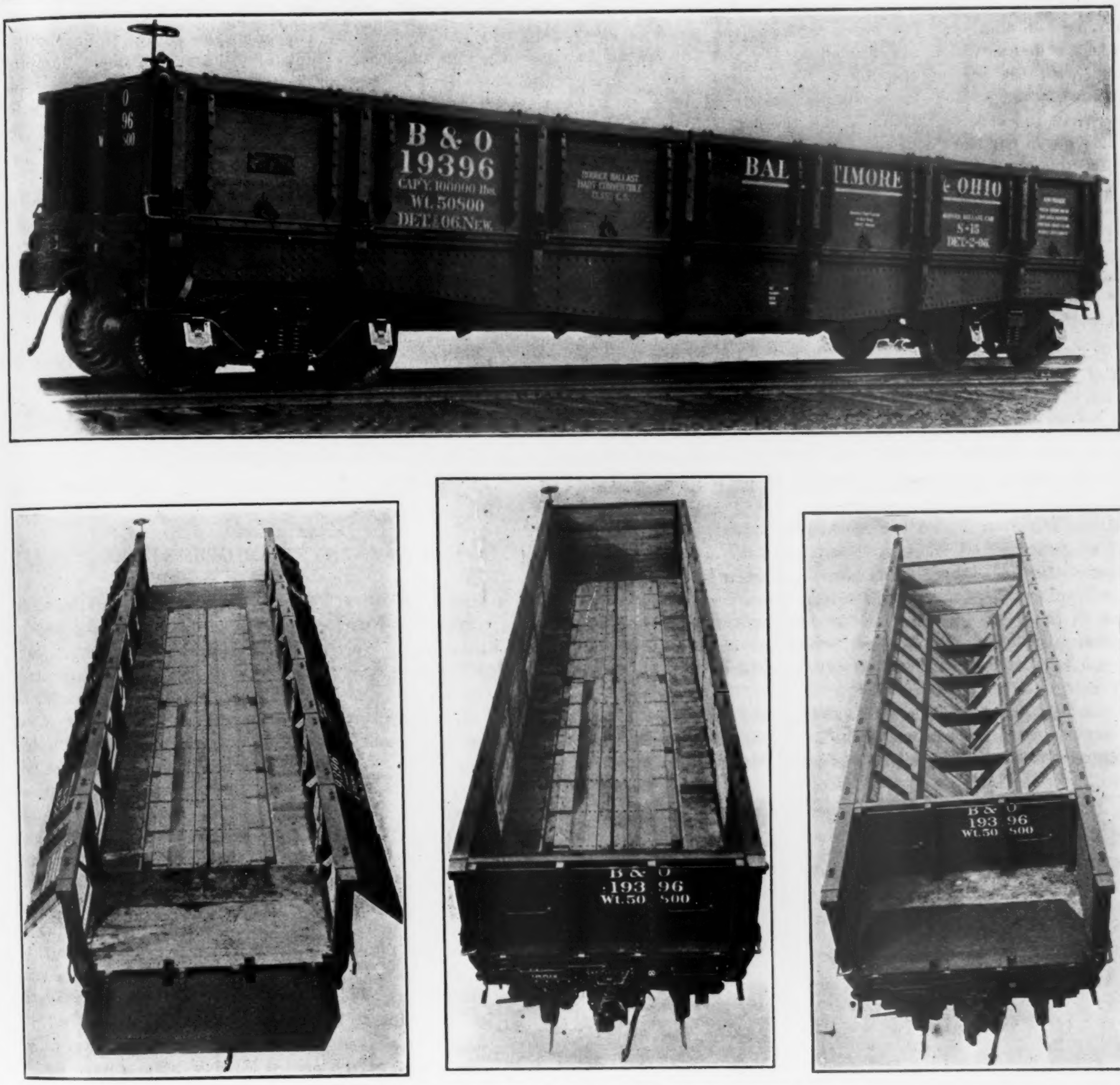
A special gauge is provided, by which the teeth can be adjusted to a uniform height ready for insertion in the saw, and when a change of teeth is necessary the time required will be simply that necessary for knocking out the wedges, removing the old teeth and inserting the new ones. It is thus possible to keep the saw in practically continuous service. The cutters are of unusual depth and strength, have sufficient metal to provide for a large number of grindings, and are made of the best grade of high-speed steel treated by the Taylor-White process. It should be noted that there are two pieces of metal between the cutter and the blade, so that the breaking of the cutter will not destroy the blade. The cutter simply mashes the soft holder, as shown in one of the illustrations. The set screw in the base of the holder is made of hard brass or bronze, which will also crush, thus relieving the blade from pressure in a radial direction. When a cutter is broken the holder is immediately removed and a new cutter inserted with very little delay.

An instance is recorded of a 40-in. saw of this type which ran continuously cutting steel castings for three months without regrinding. Such usage is not to be advocated, as better results may be obtained if the saws are ground regularly, but it will serve to give some idea of the capacity and durability of the saw. The very heavy cutting pressure upon each tooth requires special precautions for holding the work. Unless this is done, the work will slip and the saw will buckle.



ONE OF THE TOOLS AND WEDGE.

These saws were first developed for cutting armor plate at



100,000-LB. HART CONVERTIBLE CAR.—BALTIMORE & OHIO RAILROAD.

the plant of the Bethlehem Steel Company. They are used quite largely in steel foundries, forging shops, structural works and rail mills. The writer recently saw one cutting off the ends of cast iron driving box shoes in a large railroad shop, and was advised that they would easily cut off considerably more than 150 of these without resharpening. The saw which was formerly used was of the ordinary type, and after cutting off four shoes required regrinding. A special attachment is made for grinding the teeth accurately, which may be used with any wet emery grinder, or a grinder designed especially for this work is made by the Tabor Manufacturing Company of Philadelphia, manufacturers of the Taylor-Newbold saw.

MECHANICAL STOKERS FOR LOCOMOTIVES.—There is a great deal of benefit to be derived from their use. The fire is carried more uniformly all over the grate, better than can be maintained by hand firing; the contraction and expansion is less on the side sheets and flues, for the fire is bright all over the grate at all times and there is no air going into the firebox through the door, which I consider a great benefit. Engines have been run 900 miles without cleaning their fire, which could not have been done with hand firing.—*Mr. John W. Cool, Central Railway Club.*

50 TON HART CONVERTIBLE CAR.

BALTIMORE & OHIO RAILROAD.

The Baltimore & Ohio Railroad has recently received an order of 250 of the standard steel underframe 50-ton Hart convertible cars designed and built by the Rodgers Ballast Car Company.

As may be seen in the illustration, these cars are convertible from a plain gondola to a center or side dump ballast car, being so constructed that the conversion from one to the other can be made in a short time, without the use of special tools, by unskilled labor.

The underframe is of heavy steel construction, the four sills being of the built up girder type, the two immediate ones in I section and the side sills in channel section, both having a deep web at the center and being securely tied together with plates and angles at different points. The space between the two immediate sills, between the bolsters, contains no longitudinal sills and is taken up by the hopper bottom, which remains permanently in place. The cross ties between the immediate sills, however, are carried across the hopper opening, as is shown in the view of the car as arranged for center dumping. The superstructure of the car

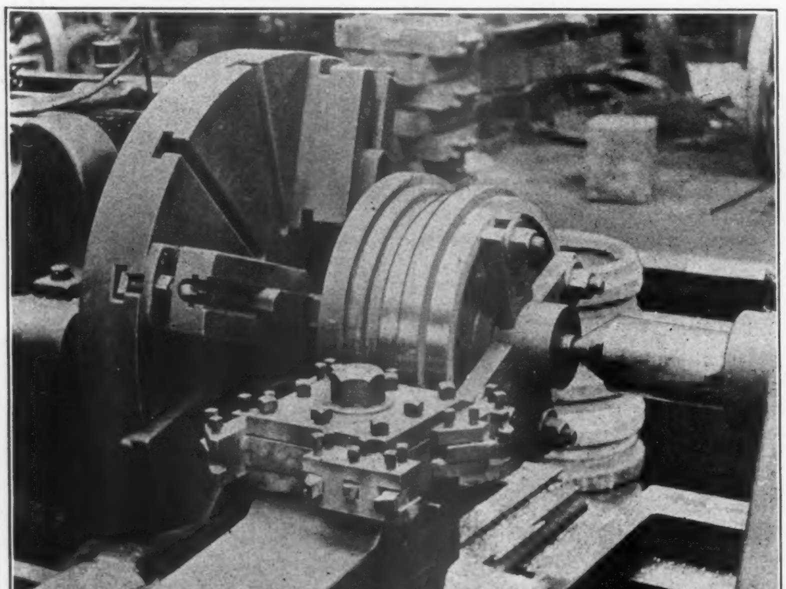
is of wood, the sides consisting of large posts and a heavy rail along the top of the posts, fastened to the steel side sills in a secure manner. The space between the posts is filled with the doors, which are hinged at the top and swing in flush with the top of the floor. These doors are securely fastened when closed by a simple design of lock, clearly shown in the side elevation. When the car is to be used as a side dump car the doors can be quickly and easily unlocked and swing outward on both sides.

When the car is to be used as an ordinary gondola the removable ends are placed in their position at the extreme end of the car; the bottom extension of the posts fitting into cast iron sockets set flush with the floor, and the top being secured by a tie rod through the side rails and the posts of the end door. The hopper in the center is covered by the swinging sections of the floor, and the car is, in fact, as well as in name, a gondola car. When it is desired to use it as a center dump-car the ends are moved forward to a point just ahead of the bolster; the swinging sections of the floor over the hopper are swung upward against the sides, there being a recess arranged so that they form a continuous surface with the sides and down into the hopper. The dumping is regulated by one operator by a lever at the end of the car which permits him to either completely release the doors dumping the whole load at once, or partially opening them so that the material can be discharged gradually. The car as arranged in this manner will carry 1,200 cu. ft. or 110,000 lbs. of ballasting material, and will entirely clear itself of the load when the hopper doors are opened.

When it is desired to use the car with an unloader or as a side dump car the ends are removed entirely and the swinging section of the floor is swung down over the hopper. The permanent aprons at the end of the car are swung out over the ends of the adjoining car, thus forming a continuous platform throughout the entire length of the train, allowing material to be ploughed to either one or both sides. As a side dump construction car the capacity is 60 cu. yds. of material. As a gondola car it has an inside length of 40 ft. and a width of 8 ft. 8 ins., and will carry 1,600 cu. ft. The average weight of a car of this type is about 45,000 lbs.

TURNING BRASS ECCENTRIC STRAP LINERS.

The illustration shows the method of turning brass eccentric strap liners on a heavy Pond lathe at the Collinwood shops of the Lake Shore & Michigan Southern Railway. The liner is of a T section and is held on a cast-iron chuck with steps to take the various diameters and with corresponding steps on the lower or arbor portion of the chuck to receive the slotted clamps. The ring or liner is held to the chuck by four studs and clamps, the setting of which is expedited by the use of a ratchet wrench. Four sets of tools are held in the square turret, as shown. The first operation consists in roughing off the two diameters, i. e., the tongue and the two



TURNING BRASS ECCENTRIC STRAP LINERS.

sides. After the tools are properly adjusted a line is scribed on the lathe carriage and the operator is thus able to make his various adjustments for both the finishing and the roughing cuts without the use of calipers. The three tools in each set make it necessary for the carriage to travel a distance only one-third the width of the liner. After the two diameters of the liner are roughed off the sides of the tongue are roughed out; for the third operation the liner is turned to the proper diameter, and in the fourth and last operation the tongue is finished to the proper width. This tool has effected a saving of 80 per cent. over former methods. We are indebted for information to Mr. M. D. Franey, superintendent of the shops.

BURLINGTON ASSOCIATION OF OPERATING OFFICERS

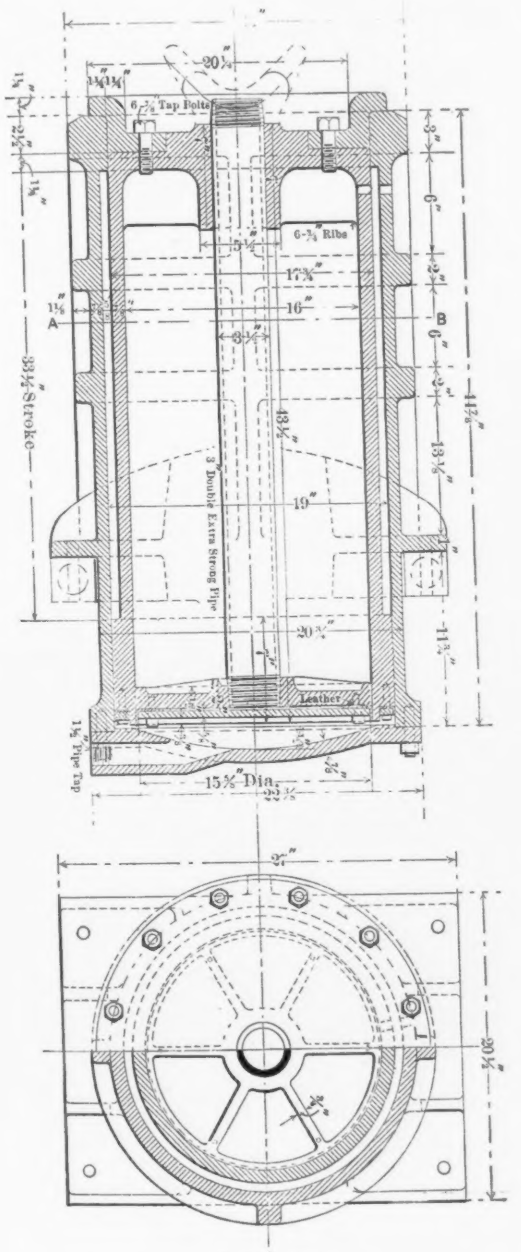
On a large railroad system the importance of periodically calling together the various officers of the operating departments to discuss the problems pertaining to their work cannot be overestimated, and it is surprising that it is not more generally done. This is true if the officers of each department meet by themselves, or more especially, if the officers of all the departments meet together and discuss problems which are common to all. A general organization such as the latter, and known as the Burlington Association of Operating Officers, has been in existence on the Chicago, Burlington & Quincy Railway for some time, and is the outgrowth of a department organization formed 20 years ago. On March 10th, 1886, the master mechanics of the Chicago, Burlington & Quincy and System Lines met at Aurora, Ill., and organized a master mechanics' association with a membership of 15 to 20. Mr. G. W. Rhodes, then superintendent of motive power, was elected chairman, and served in that capacity until 1903. The meetings were held semi-annually until 1898, and since then annually. The object of the organization was the discussion of questions of mechanical detail and the establishing of standards and practices pertaining to the motive power department.

From the very first the members took a considerable interest in the meetings, as did also a number of the other officials. In November, 1896, the superintendents first met in joint session with the master mechanics, and they also organized a superintendents' association. From that time until 1902 meetings were held jointly and separately by both these associations. In March, 1903, the two associations were consolidated, and the Burlington Association of Operating Officers was organized with a regular constitution and by-laws. The officers of this association consist of a chairman, a first and second vice-chairman and a secretary, who perform the duties usually devolving upon such officers. The executive committee is composed of the chairman, and the vice-chairmen of the association, together with the general managers of the Lines East and West or representatives annually appointed by them. This committee selects the subjects which appear to be of more general interest from those which the members have been invited to hand in, and the members are notified by a printed program of all new subjects introduced for discussion at least three weeks prior to the time of meeting. They decide on the time and place of all meetings, and have general

charge of the affairs of the association.

Altogether 38 meetings have been held, and 16 different points on the line have been visited, among them Chicago, Aurora, Omaha, Kansas City, St. Louis, Denver, St. Paul and others.

A regular order of business is followed at the meetings, and they are conducted in about the same way as those of the Master Car Builders' and American Railway Master Mechanics' Associations. Fifteen members, including the chairman, constitute a quorum for the transaction of business. The membership of the association consists of the general officers of the system and the following representatives from the Lines East and West. General managers, general superintendents, assistant general superintendents, superintendents of divisions and terminals, assistant superintendents of divisions and terminals, chief engineers, engineer Lines East and West, engineers maintenance of way, superintendents of



Section A-B

TELESCOPIC PNEUMATIC JACK.—L. S. & M. S. RY.

motive power, mechanical engineers, engineers of tests, superintendents of shops, master mechanics of divisions and terminals, assistant master mechanics of divisions and terminals, general piece work inspectors, mechanical inspectors, inspectors of transportation, supply agents and auditors. Officials of the various departments not eligible for membership may be present at any meetings of the association upon invitation of the head of their department or of the executive committee, but do not take part in the proceedings unless invited by the chairman. The association has an active membership of about ninety at the present time.

Committees for the investigation of special subjects ordered by the association are appointed by the chairman, and serve until discharged by action of the association. There are also several standing committees, such as motive power statistics, motive power standards, train rules, permanent way, blanks, etc.

WHAT HAS BEEN ACCOMPLISHED.

Since the organization of the association in 1886 something over one thousand subjects have been considered. Nearly 60 per cent. of these have been submitted to the management, approved and made the standard practice of the road.

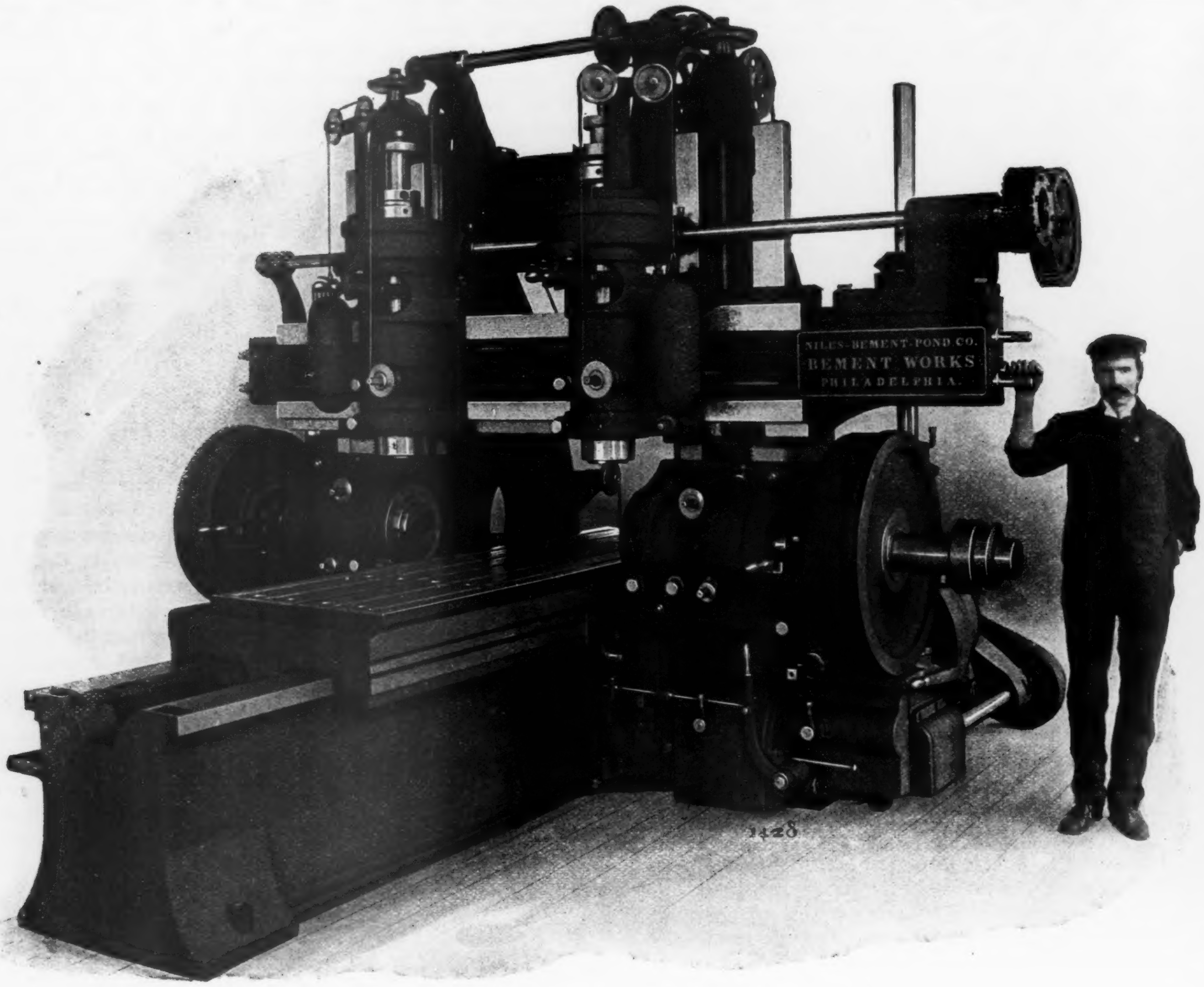
From a mechanical standpoint the association has been instrumental in bringing about a great many standards relating to rolling stock and other equipment of the road; it has tended to diffuse much information concerning new practice and ways of doing work between the different shops, thereby reducing the cost. It has created a lively interest and rivalry between the different divisions in the matter of economy and workmanship. One of the special aims of the association has been the co-operation of the different departments, the bringing together of superintendents, master mechanics and others and interesting them in each other's work through the discussion of subjects of mutual interest, such as the maintenance of permanent way, structures of all kinds, operation of trains, handling of freight, etc., which are of interest to master mechanics and superintendents alike. A concluding thought may well be expressed in the words of a former member. "I have very great faith in the efficiency of the workings of this joint association. I believe that in years to come the progress of the Burlington road will be written in the minutes of this association; the progress in economics; progress in improved methods; progress in all material things will be written in the minutes of these meetings." We are indebted for this information to Mr. S. D. Brown, secretary of the association.

TELESCOPIC PNEUMATIC JACK FOR DRIVING WHEEL DROP PITS.

The Lake Shore & Michigan Southern Railway has recently found it necessary to redesign its telescopic pneumatic jack used in connection with the driving wheel drop pits in the roundhouses. Upon the advent of the heavy Class J 41 Prairie type engines the jacks formerly used proved unsatisfactory, for the reason that the excessive weight of the wheels and axles (the weight of a pair of main drivers complete, including the centers, tires, axles, crank pins, driving boxes and eccentrics, is over 13,000 lbs.), and the height to which it is necessary to extend the jack (79-in. wheels), were such that unless it was placed exactly under the center of the axle the jack would become cocked in such a way as to lock it. When it gave way the force of the blow would break the cylinders and endanger the operator.

To overcome this the design was changed, with satisfactory results, to that shown in the illustration. The length of the bearings of the piston rod, piston and the two cylinders were increased considerably, so that when the jack was extended to its full height there would be no opportunity of its binding and sticking. The diameter of the inner cylinder was increased from 15 to 16 inches and of the outer one from 17½ to 19 ins. The various parts were strengthened, and the outer cylinder was ribbed, as shown. These jacks are supported by 3 by 3-in. wrought iron bars, which have journals at each end for 18-in. wheels equipped with roller bearings. We are indebted to Mr. R. B. Kendig, mechanical engineer, for drawings and information.

REMOVING A RUSTED SCREW.—Apply a red-hot iron to the top so as to heat it and immediately use screw-driver.—*American Machinist.*



BEMENT FOUR-HEAD MILLING MACHINE.

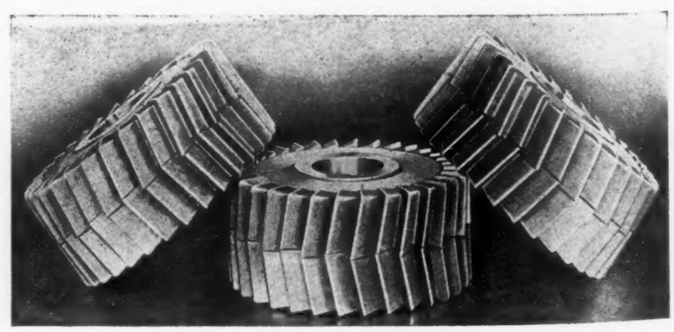
FOUR-HEAD MILLING MACHINE.

During the past few years the planer and vertical types of milling machines have rapidly come into general use in our railroad shops and are giving very satisfactory results. Interesting examples of work done by these two classes of machines will be found on pages 14, 32, 176, 228, 406, 409 and 449 of our 1905 volume, and on page 26 of our January, 1906, issue. The heavy milling machine is far superior to the planer for certain classes of work. In machining locomotive guides, for instance, where a good finish is desired, a roughing and a finishing cut are required on a planer, while only one cut is necessary with the milling machine and a better finish is obtained. By the use of gang cutters several surfaces may be machined at one time on the milling machine.

A combination of these two types, known as the four-head milling machine, and shown in the accompanying illustration, has all the advantages of the planer type miller and a number of the advantages of the vertical type machine, and should prove invaluable for use in the larger railroad shops, at least. An interesting description of the milling of locomotive side rods on a machine of this type, where all four cutters are used at the same time, will be found on page 24 of our January, 1906, issue.

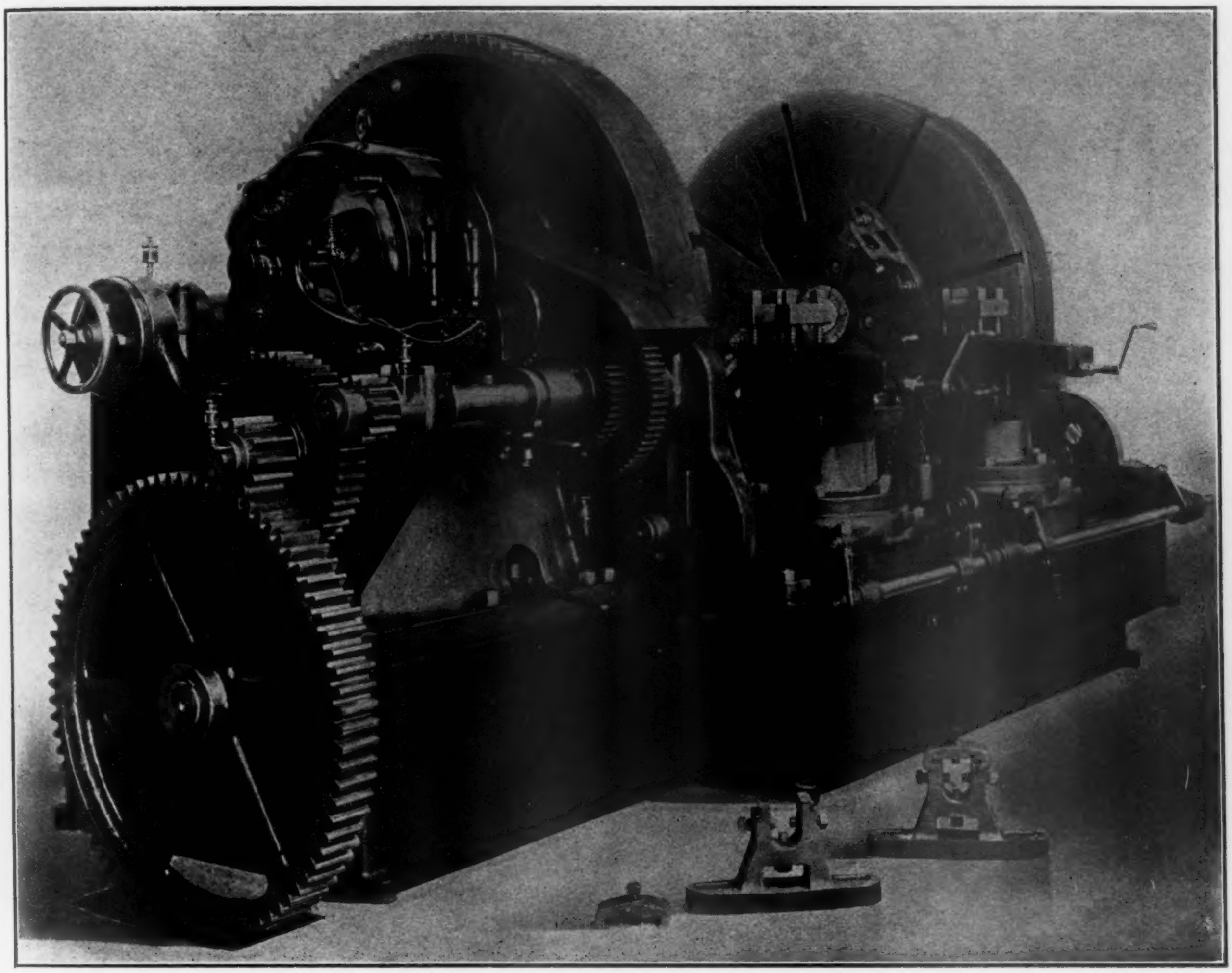
The variety of ways in which the various spindles may be used is almost endless. In milling castings the vertical spindles can be used to reach down and finish bosses, which are difficult to get at, at the same time that the horizontal spindles are machining the sides of the piece. The two horizontal spindles may be used for driving an arbor on which gang cutters are placed. One of the vertical spindles can be used to finish the end of a piece at one setting, the head being fed along the crossrail.

The machine illustrated is intended for work 36 ins. wide and 36 ins. high. The width between uprights is 43 ins. The table is 35 ins. wide and 8 ft. long, but the machine can be built to mill any desired length. The horizontal spindles have eight speeds, a maximum diameter of 8 ins., and a traverse of 10 ins. The maximum distance from the center of the horizontal spindles to the table is 30½ ins., minimum 4 ins. The maximum distance between the ends of the horizontal spindles is 43 ins. The maximum diameter of the vertical spindles is 6 ins.; traverse, 8 ins.; number of speeds, sixteen. The maximum distance from the ends of the vertical spindles to the table is 42 ins., minimum 8 ins. This machine is made at the Bement works of the Niles-Bement Pond Company.



INTERLOCKING MILLING CUTTERS.

One of the illustrations shows an interlocking milling cutter made by the Pratt & Whitney Company, which may be used



RIDGEWAY HEAVY 90-IN. DRIVING WHEEL LATHE.

for the channeling of locomotive rods, or for similar work where it is necessary to have a given width of groove and maintain a constant width of cut. The cutters are made in halves, the teeth of one-half interlocking with the other half. As the cutters are ground, washers can be placed between the two halves, thus keeping the width constant. This may also be accomplished with the inserted teeth cutters.

HEAVY 90-INCH DRIVING WHEEL LATHE.

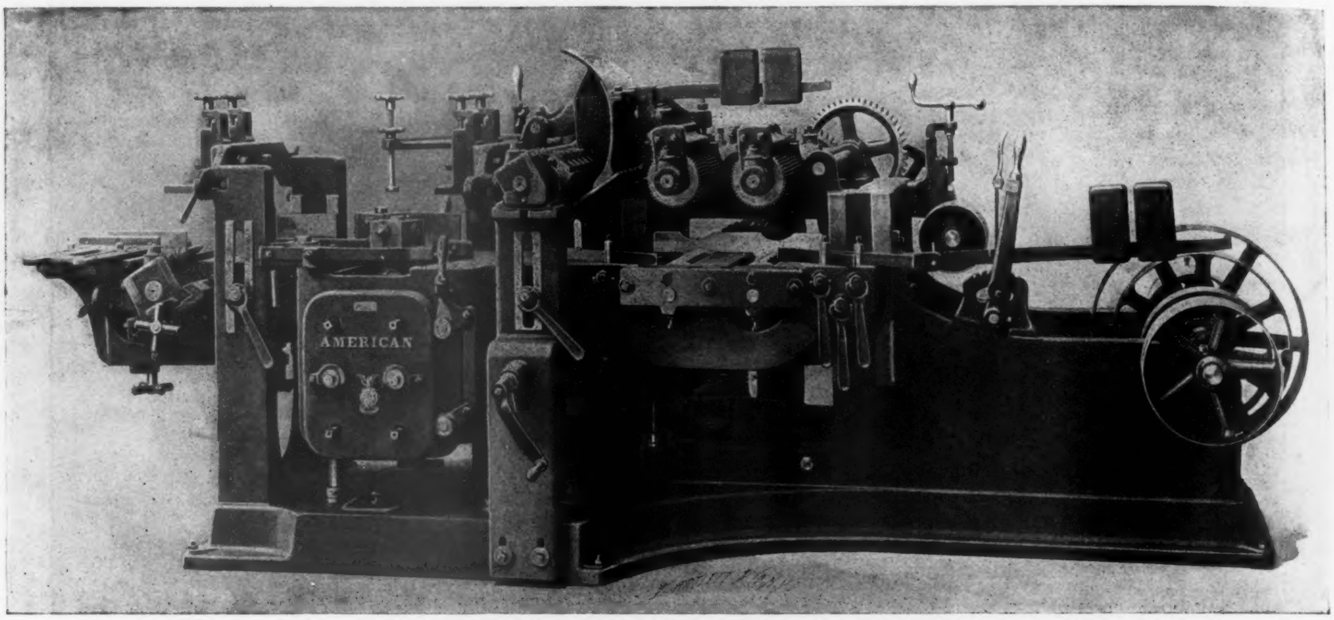
In a recent test the heavy 90-in. motor-driven Ridgeway driving wheel lathe, illustrated herewith, turned a badly worn pair of driving wheels, 57 ins. in diameter, in 59 minutes actual cutting time. The machine stood on the floor of the shop at the builders, and it was, therefore, impossible to force it to an extent that would have been possible if it had been set on its proper foundation. A ½-in. cut with a ⅛-in. feed was operated at a rate of 16 ft. per minute for the first 1½ ins. across the tread. The feed was then increased to ¼ in., shortly after which one of the high-speed tools gave out. Two other tools broke down before the cut was finished. The 59 minutes includes the time for replacing the tools. One hundred and eighty pounds of metal were removed, and the power consumed varied from 6 to 26 h.p. This machine was made by the Ridgeway Machine Tool Company, and was driven by a Thompson-Ryan variable speed motor having a speed range of 4 to 1.

The machine is of compact and substantial design, and the driving dogs and face plates are so designed that the wheels may be set very close to the face plates. The rests are arranged to give only a very slight overhang to the tools, and the bed is extended at the front in order to give a solid support for the rests. Recesses are arranged in the face plates for the crank pins, thus allowing the wheels to be brought close to the face plates. A small electric motor is attached to the tail stock, and is geared directly to a traversing screw for moving the head back and forth. One of the gears is arranged to slip at a certain point, so that it is possible to run the motor at full speed, bringing up the center at a rapid rate and avoiding the necessity of slowing down. The power of this device may be adjusted, so that the necessary force is applied to bring the center solidly into place, thus avoiding the necessity of adjusting the centers by means of a hand wheel.

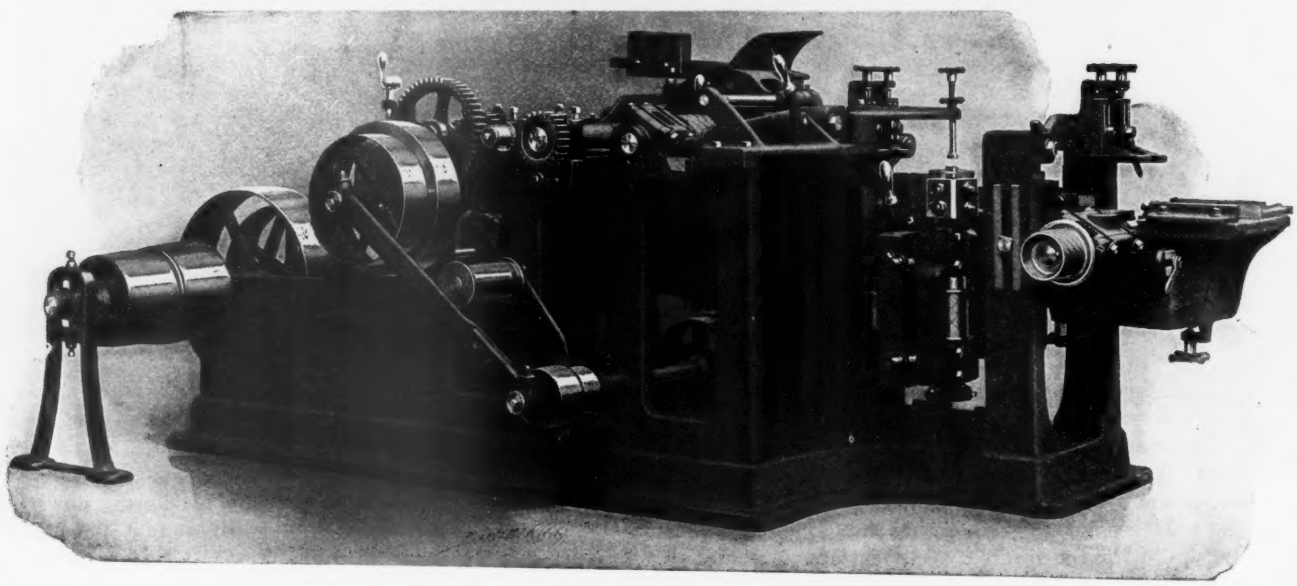
The sides of the tool rests next to the face plates are cut away at the top and reinforced on the under side, in order to allow the driving dogs to be brought as near the rim of the wheel as possible. The tool blocks have swiveled compound slides, with power feed in any direction, and may be set to turn wheels from 48 to 90 ins. in diameter. The right hand rest is provided with power traverse.

The driving dogs grip the rims of the wheels firmly, and by means of a cap, which is slipped on after the wheels are in place, buckling or distorting of the wheels is prevented. Two of these driving dogs are shown in the foreground of the illustration, one having the cap removed. The feed is taken directly from the face plate, and the feed lever is placed so that the operator can adjust the amount of feed without leaving the work. The face plates may be driven independently or together, as desired. The face plates have 20 speeds ranging from .227 to 2.68 r.p.m. for turning tires and from 4.53 to 54 r.p.m. for turning journals. The machine weighs 90,000 lbs., and is driven by a 30-h.p. motor. If desired, it may be equipped with a quartering attachment.

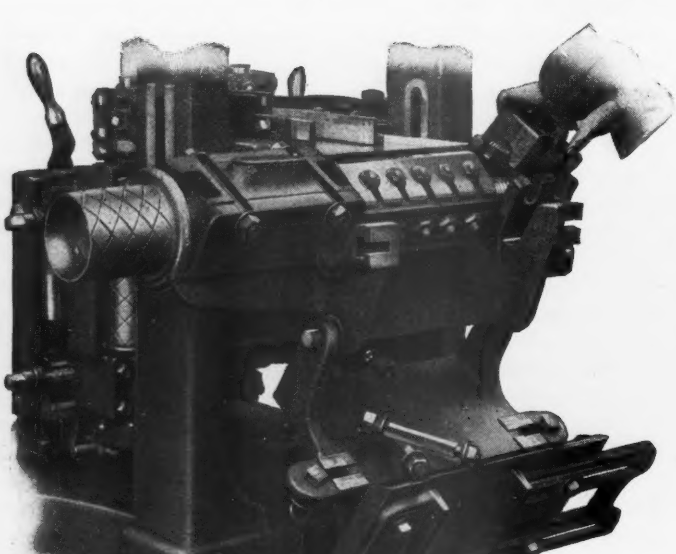
EMPLOYEES' SAVING FUND.—The employees' saving fund of the Pennsylvania Lines West of Pittsburg, amounted to $459,276.53 on December 31, 1905. The members received 4 per cent. on their deposits.



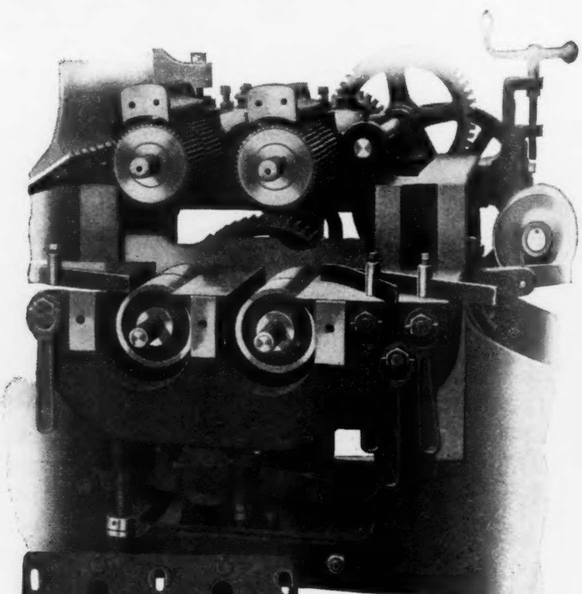
FRONT VIEW.



REAR VIEW.



END VIEW—BED DOWN, SHOWING BOXES, ETC.

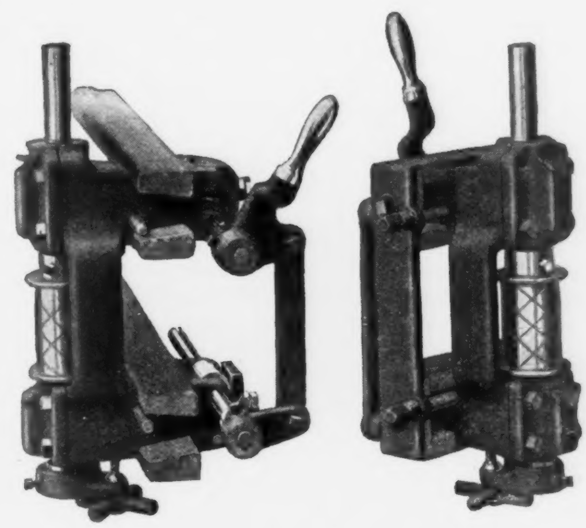


ROLLS AND DETACHED BOXES.

AMERICAN FOUR-COLUMN OUTSIDE MOULDER.

NEW FOUR COLUMN OUTSIDE MOULDER.

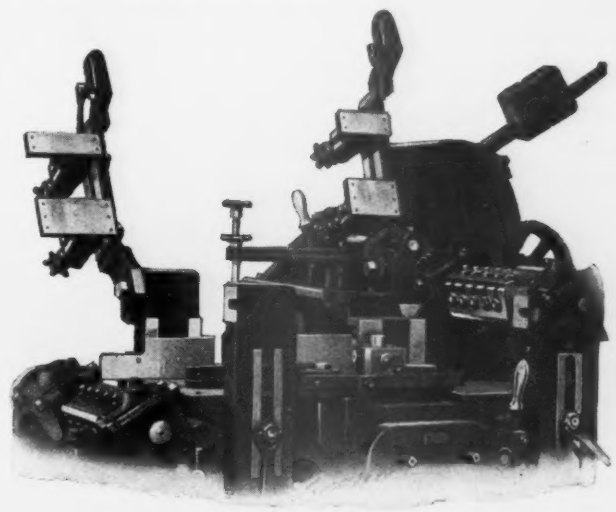
The American four-column outside moulder, shown in the illustrations, is made in two sizes and will work all four sides of a piece 12 or 14 ins. wide by 6 ins. thick; the table drops 8 ins. The machine is easily adjusted and has several mechanical devices, a few of which are illustrated, that greatly increase its capacity. In addition to the frame, the base supports three columns; one column supports the outer end of the top arbor, preventing vibration when taking deep cuts; the other two support the rear end of the bed carrying the bottom cutter head. The bed is securely gibbed to the frame and is raised and lowered by two large screws, which rest on ball bearings and are both operated by the same crank. There is a detachable bed plate directly under the top cutter head, which is reversible, with one side plain and the other side grooved, to allow the cutters to project lower than the bed. The extension of the bed beyond the bottom cutter head drops down, giving free access for adjusting the cutters.



INSIDE AND OUTSIDE HEADSTOCKS.

The feed rolls are 6 ins. in diameter and have an improved direct-gear drive for the top and bottom rolls, making a powerful and positive feeding device. The feed rolls are supported with outside bearings and the bottom rolls can be removed and replaced by removing three bolts, as shown in one of the illustrations, and without disturbing any part of the machine proper. The spindles are of large diameter, run in self-oiling boxes and are provided with what is known as a pneumatic pulley, overcoming the necessity for tight belts, with a consequent saving in power. The top and bottom spindles are equipped with patent side-clamping boxes, which may be easily and accurately adjusted. The belt driving the top head has an adjustable tightener, by means of which the slack may instantly be taken up and permitting no greater strain than is necessary when running on a lighter class of work.

The bars that carry the adjustable cutter shoes, over the under cutter and directly back of the top cutter head, are hinged and may be thrown back; they are supported at both ends and each shoe is vertically adjustable by a screw and hand wheel. The chip breaker and hood for the top head may be thrown up and back across the machine, giving free access to the top head. The side head may be set to any angle and moved vertically and laterally without changing the angle, and one movement of the lever locks the head stock at both the top and bottom.



UPLIFTED BARS. CHIP BREAKER SWUNG UP AND SLID ALONG, GIVING FREE ACCESS TO CUTTER HEAD KNIVES.

There is a lever adjustment for the independent bed-plate section before the bottom head, for unlocking and adjusting without the use of a wrench.

The cutter heads are provided with vertical and lateral adjustments and have a normal cutting circle of 6 ins. The top head cutters project 3 ins., giving a cutting swing of 6 ins. over the normal cutting circle, making 12 ins. maximum swing. The under cutter head is provided with an adjustable plate each side of the head, allowing the knives to project 3 ins. The inside head has an adjustable chip breaker and guide, allowing the knives to project 2½ ins. The outside head has a combined chip breaker and guide, allowing the knives to project 2½ ins. Four rates of feed are provided: 17, 25, 34 and 49 ft. per minute. The weight of the 14-in. machine is 7,200 lbs. These machines are made by the American Wood Working Machinery Company.

PERSONALS.

Mr. C. M. Mileham has resigned as master mechanic of Street's Western Stable Car Line.

Mr. L. M. Dempsey has been appointed master mechanic of the Mexican Central R. R. at Ciudad Juarez, Mex.

Dr. W. K. Hatt has been appointed professor of civil engineering at Purdue University, effective September 1.

Mr. L. A. Cross has been appointed road foreman of engines of the Peoria & Eastern Railway at Indianapolis, Ind.

Mr. L. P. Goodwyn has been appointed master mechanic of the Texas and Gulf Railroad, with office at Longview, Tex.

Mr. P. J. Schuyler has been appointed road foreman of engines of the Philadelphia & Reading Railway at Harrisburg, Pa.

Mr. F. H. Sweringen has been appointed master car builder of Street's Western Stable Car Line, with headquarters at Chicago.

Mr. J. P. Murphy has been appointed general storekeeper of the Chicago, Indiana & Southern Railroad, with office at Collinwood, Ohio.

Mr. W. F. Garabant has been appointed general air brake and steam heat inspector of the Pennsylvania Railroad, with office at Altoona, Pa.

Mr. W. C. A. Henry, heretofore master mechanic of the Pennsylvania Lines, Northwest System, at Wellsville, O., has been transferred to Columbus, O., as master mechanic.

Mr. R. L. Kleine, general car inspector at Altoona, Pa., has been appointed assistant chief car inspector, with headquarters at the same place.

Mr. W. S. Miller, master mechanic on the Pennsylvania Lines at Columbus, O., has resigned to become vice-president and general manager of an electrical company of Philadelphia.

Mr. W. J. Pollock has resigned as foreman of the Pennsylvania Railroad freight car repair shop at Altoona, Pa., to go into private business.

Mr. J. J. Clark has been appointed master mechanic of the Nashville Terminal Company, with office at Nashville, Tenn., to succeed Mr. G. B. Longstreth, resigned.

Mr. D. J. McNerney has been appointed master mechanic of the Tacoma Eastern Railway, with office at Bismarck, Wash., succeeding Mr. H. F. Weatherby.

Mr. M. J. Henegan has been appointed road foreman of engines of the Cleveland, Akron & Columbus Railway, at Columbus, Ohio, vice Mr. J. B. Ward, resigned.

Mr. C. D. Young has been appointed assistant master mechanic of the Pennsylvania Lines, Northwest system, at Fort Wayne, Ind., vice Mr. N. M. Loney, promoted.

Mr. N. M. Loney, assistant master mechanic of the Pennsylvania Lines, Northwest System, at Fort Wayne, Ind., has been appointed assistant engineer of motive power at Fort Wayne.

Mr. Oscar Antz, general foreman on the Lake Shore & Michigan Southern Ry., at Elkhart, Ind., has been appointed general locomotive inspector of the New York Central Lines.

Mr. H. S. Needham has been appointed assistant motive power inspector of the Pennsylvania Lines, southwest system at Columbus, O., to succeed Mr. Charles D. Young, promoted.

Mr. A. C. Davis, heretofore assistant engineer of motive power of the Northwest system, Pennsylvania R. R., at Fort Wayne, Ind., has been appointed master mechanic at Wellsville, O.

Mr. H. F. Ball, superintendent of motive power of the Lake Shore & Michigan Southern Railway, with headquarters at Cleveland, O., has had his jurisdiction extended over the Chicago, Indiana & Southern Railroad.

Mr. C. O. Keagy, general foreman of passenger car inspectors at the West Philadelphia shops, Pennsylvania R. R., has been appointed general car inspector at Altoona, to succeed Mr. Kleine.

Mr. W. A. Moody, heretofore chief draftsman of the Illinois Central R. R., has been appointed acting mechanical engineer with office at Chicago, succeeding Mr. J. H. Wynne, mechanical engineer, resigned.

Mr. F. P. Pfahler, heretofore draftsman of the Baltimore & Ohio Railroad, at Baltimore, Md., has been appointed mechanical engineer of the Wheeling & Lake Erie Railroad, with office at Norwalk, Ohio.

Mr. H. S. Lloyd has been appointed master mechanic of the Chattanooga Southern R. R., with headquarters at Alton Park, Tenn., and Mr. J. B. Crabb has been appointed foreman at that place.

Mr. George B. Fravel has been appointed master mechanic of the Logansport division of the Pennsylvania Lines, southwest system, with office at Logansport, Ind., to succeed Mr. G. C. Bishop, resigned.

Mr. J. T. Flavin has been appointed master mechanic of the Chicago, Indiana & Southern Railroad at Hammond, Ind., and Kankakee, Ill. Heretofore Mr. Flavin has been assistant master mechanic of the Indiana, Illinois & Iowa R. R.

Mr. C. H. Mead, general car foreman of the Iowa Central at Marshalltown, Ia., has been appointed master car builder of the Isthmian Canal Commission, under Mr. George D. Brooke, superintendent of motive power at Ancon, Panama.

Mr. G. C. Bishop, master mechanic of the Pennsylvania Lines, Southwest system, at Logansport, Ind., has been appointed superintendent of motive power of the Long Island R. R., with office at Richmond Hill, Morris Park, N. Y., to succeed Mr. Phillip Wallis, resigned.

Mr. W. L. Harrison, heretofore master mechanic of the Chicago, Rock Island & Pacific Railway, at Horton, Kans., has been appointed acting superintendent of motive power, with office at Chicago, during the illness of Mr. J. B. Kirkpatrick. Mr. S. W. Mullinix has been appointed master mechanic at Horton, to succeed Mr. Harrison.

Mr. A. E. Mitchell has resigned as superintendent of motive power of the Lehigh Valley R. R., to be effective June 1. He will be succeeded by Mr. F. N. Hibbits, mechanical superintendent of the New York, New Haven, & Hartford R. R., who in turn, will be succeeded by Mr. Frank T. Hyndman, general master mechanic of the N. Y., N. H. & H. R. R.

Mr. J. J. Walsh, general foreman of the Pennsylvania Lines, Northwest system, at Toledo, O., has been transferred to Chicago as master mechanic of the Chicago Terminal division, succeeding Mr. George B. Fravel, transferred. Mr. O. P. Reese, heretofore motive power inspector, has been appointed general foreman at New Castle, Pa., in place of Mr. T. F. Dreyfus, who has been appointed to succeed Mr. Walsh as general foreman at Toledo.

BOOKS.

Shaft Governors. By W. Trinks and C. Housum. 97 pages. Published by D. Van Nostrand Company, New York. Price, 50 cents.

This volume, which is expected to be the first of a series on this important subject, is given up largely to the statistics of shaft governing and contains a large amount of matter illustrated with plates, in connection with the design of satisfactory shaft governors. The subject is treated very thoroughly.

Manual for Engineers. Compiled by Chas. E. Ferris. Sixth Edition. Published by the University of Tennessee, Knoxville. Price, 50 cents.

This small pocket book contains a large amount of valuable matter for both engineers and business men in the shape of detailed and general information. The first few pages are devoted to a brief account of the courses offered at the University of Tennessee. The book is of vest pocket size, printed on thin paper with a flexible cover.

Tests of Metals. Government Printing Office, Washington, D. C.

This book is a report of the tests made with the United States testing machine at the Watertown Arsenal during the year ending June 30, 1905. It contains a full account of tests, to the number of 32, on a large variety of subjects, including steel castings and forgings, steel wire, helical springs, roller bearings, railroad material, concrete, brick, marble, blue print paper and many others. The book is nicely illustrated with half-tone engravings on special surface paper and contains much valuable matter.

The Indicator Hand Book. By C. N. Pickworth. Third Edition. 126 pages. Published by D. Van Nostrand Company. Price, 75 cents.

This book, which is very profusely illustrated, is prepared for the purpose of furnishing engineers with a practical hand book which fully describes the modern indicator and its application. It discusses the errors of the instrument, particularly those due to its faulty attachment and actuation, and considers methods for correcting them. Many different types and designs of indicators are shown, as well as many forms of connections. Steam pipe connections, valves, etc., are included.

Reinforced Concrete. By F. D. Warren. 271 pages. Published by D. Van Nostrand Company. Price, $2.50.

The author states that he has endeavored to produce a reference hand book that would be useful to architects, engineers and contractors. The book is divided into four parts, the first of which contains a general review of the subject from a practical standpoint, bringing out some of the difficulties met with in practice and suggesting remedies. Part two is a series of tests justifying the use of various constants and co-efficients. Part three is a series of tables from which the designer may obtain necessary information to meet the common cases in practice. Part four treats of the design of trussed roofs from a practical standpoint. The book contains a number of illustrations in addition to many curves and tables.

Details of Bridge Construction. Part II. Plate Girders. By Frank W. Skinner. Published by the McGraw Publishing Company, 114 Liberty Street, New York, N. Y. 1906. Illustrated. 412 pages. Price, $4.00.

The volume is divided into six parts, as follows: General features of design, construction and service; examples of railroad plate girder spans; details of bearings and splices; multiple railroad spans on steel towers; highway and special spans; discussion of plate girders by eminent designers. It is intended to make it a complete epitome of American practice in plate girders, to describe and illustrate as many important examples as possible, to accompany them with a comprehensive review of ordinary conditions, requirements, methods and explanations of the computation, design and execution of the work and to arrange the data so as to present a complete record for reference and consultation, useful for design and estimate, and especially for convenient illustration and comparison of plate girder essentials, for guidance, suggestion, or modification in new work.

Electrical Engineering in Theory and Practice. By G. D. Aspinall Parr, Head of the Electrical Engineering Department, The University, Leeds. Published by The Macmillan Company, 66 Fifth Avenue, New York City. 1906. 450 pages. 282 illustrations. Price, $3.25.

Except in a few cases where they embody important principles, all historical matter and obsolete appliances have been excluded, the endeavor being to produce a work fully up to date. The fundamental principles of magnetism and electricity are first considered, and this is followed by chapters on electrical resistance, electro-magnetism, electro-static and electro-magnetic induction, electrical and magnetic instruments, incandescent lamps, arc lamps, and the production of electro-motive force (thermo-generators, primary and secondary cells). It is expected that the theory of the generation, transformation and distribution of continuous and alternating currents, together with electrical machinery and other appliances most commonly met with in electrical engineering will form the subject matter of a second volume. A series of carefully chosen questions are given at the end of each chapter.

CATALOGS.

IN WRITING FOR THESE, PLEASE MENTION THIS PAPER.

TRANSFORMERS.—Bulletin No. 65 from the Crocker-Wheeler Company, Ampere, N. J., contains a reprint of an illustrated article by A. H. Pikler in the *Electrical World*, describing their core type transformers, manufactured in all sizes up to 4,000 kva, for any commercial frequency and for all votages up to 200,000.

WILLIAMS FRICTION CLUTCH.—The Williams Electric Machine Company, Akron, Ohio, is issuing a leaflet descriptive of a special design of friction clutch manufactured by it, which contains a number of interesting features. These clutches are very compact and are capable of transmitting a large amount of power.

TRUCKS ET VOITURES DE LA J. G. BRILL CO.—The J. G. Brill Company, of Philadelphia, is issuing a special catalog in French under the above title, which is intended for distribution in connection with its exhibit at the Milan Exposition. This is arranged in a most artistic manner and shows many illustrations and drawings of the special trucks and electric cars manufactured by them.

VENTILATORS.—The Globe Ventilator Company, Troy, N. Y., is issuing a pamphlet devoted principally to the application and value of the Globe ventilator for use on passenger coaches. The important subject of proper passenger car ventilation is briefly considered and the success obtained by the use of the Globe design is shown. This type of ventilator is also in use on many shops and roundhouses.

BUDA HAND CARS.—The Buda Foundry & Manufacturing Company, Railway Exchange, Chicago, is issuing a catalog which illustrates and describes many different designs of hand cars, push cars and railway velocipedes, all of which are equipped with the Buda pressed steel wheel, which is also shown in section. The method of manufacture and advantage of this type of wheel are clearly set forth.

LOCOMOTIVE CRANES.—The Wellman-Seaver-Morgan Company, Cleveland, Ohio, is issuing a catalog containing a number of illustrations showing locomotive cranes of different sizes operating under different conditions, both in connection with buckets for hoisting coal or ore, as well as a regular crane for the distribution of heavy parts. These cranes are used at some points for coaling locomotives, removing cinders from the cinder pit and similar work.

AIR COMPRESSORS.—The Ingersoll Rand Company, 11 Broadway, New York, is issuing a very complete catalog giving illustrations, descriptive matter and details of sizes and capacities of a large number of different designs of air compressors manufactured by it. These are shown for driving with steam, electricity or water power, in both vertical and horizontal connections. Reheaters, tanks and details of the air compressors are also illustrated and described.

WATER SOFTENING.—William B. Scaife & Sons Company, Pittsburg, Pa., is issuing a small folder, the outside having the appearance of a ledger, which includes a photographic reproduction of two pages of an actual ledger kept by a manufacturing company operating a 2,000 h.p. boiler plant, one page of which shows the cost of maintenance of boilers before and the other after the installation of water softening and purifying plants. The figures are most interesting and the leaflet can be obtained upon request.

MACHINE TOOLS.—*Progress Reporter*, No. 12, published by the Niles-Bement-Pond Company, describes several machine tools which are of special interest to those interested in railroad shop operation. Among them is a four-head milling machine, 79-in. standard driving wheel chucking lathe, 66-in. vertical milling machine, 300-ton hydraulic wheel press, 12in. crank slotter, two-head frame slotter, four-spindle multiple drill, locomotive rod boring machine, 200-ton sectional hydraulic flanging machine and a motor-driven bending rolls.

CHICAGO CAR HEATING COMPANY.—A very attractive catalog has been issued by the Chicago Car Heating Company, Railway Exchange Building, Chicago, which thoroughly describes the new vapor system of car heating recently perfected, as well as the straight steam pressure system and hot water systems furnished by it. The catalog contains several large colored plates, sectional elevations of apparatus and perspective views of installments for the different systems, and reading matter which covers every point of operation. A large number of appliances and parts used in connection with car heating apparatus are also shown and described.

TEST OF ROLLER BEARINGS VS. GRAPHITE.—The May issue of "Graphite" contains an account of some tests recently made by Professor Benjamin, of the Case School of Applied Science, as a supplement to the tests recently made by Professor Goss, of Purdue University, which showed a large reduction of friction by the use of graphite as a lubricant. These experiments were a comparison of the friction developed by a plain bearing with graphite lubricant and ordinary roller bearings, and showed that the latter gave nearly four times the co-efficient of friction when the pressure was 50 lbs. per sq. in. The test also showed that the bearing lubricated with graphite was able to carry a load nearly 100 per cent. greater than the roller bearing.

RECORD OF RECENT CONSTRUCTION No. 55.—The latest Record of Recent Construction issued by the Baldwin Locomotive Works is entitled "Walschaert Valve Gear," and contains a large amount of historical, descriptive and instructive matter in connection with this type of valve gear. The descriptive matter contained in this pamphlet was partially reprinted in the AMERICAN ENGINEER AND RAILROAD JOURNAL, February, page 55. General views and dimensions of a number of locomotives which have been built by this company equipped with this type of gear are also shown. In view of the increasing popularity of the Walschaert valve gear in this country, the matter contained in this book will be found to be of interest and value to all motive power men.

Motors and Generators.—Bulletin No. 64, from the Crocker-Wheeler Company, Ampere, N. J., describes their type I motor and generator and illustrates a number of motor applications to machine tools. Some modifications have recently been made in the frame of this motor so that it has all the advantages of the open type, but may be fully enclosed if conditions or operation so require.

General Electric Company.—This company during the past month has issued several very interesting catalogs dealing with electrical apparatus. One of these, entitled "Lightning Arresters," considers the important question of protection from lightning shocks in general and describes an improved form of multiplex arresters recently perfected by this company. Other and older types for all currents and voltages are also shown in the catalog and its supplement. This includes many diagrams of wiring connections under different circumstances. A supply catalog giving illustrations with detail parts and a complete price list of the Sprague General Electric type M control apparatus is also being sent out. A similar supply catalog of marine supplies for electrical work of all kinds can also be obtained by those interested.

Pacific Type Passenger Locomotives.—A pamphlet just issued by the American Locomotive Company describes Pacific type passenger locomotives built for various railroads. The pamphlet opens with a description of the Pacific type and an outline of its special advantages for very heavy and fast passenger service. These are very briefly stated and are followed by a description of two forms of trailing trucks which have been used with great success on this type of locomotive. The description is followed by two pages of tables containing, in condensed form, the leading dimensions of all the locomotives illustrated in the pamphlet, the tables being arranged in the order of the total weight of the locomotives. By use of side elevation and sectional drawings a typical Pacific type locomotive is illustrated and engravings of outside and inside bearing trailing trucks are included. The remainder of the pamphlet is devoted to photographic reproductions of locomotives, the opposite pages containing tabular information concerning each design. The locomotives are placed in the order of their weights.

This is the first of a series of catalog pamphlets to be issued by the American Locomotive Company, which will eventually include all the standard types of locomotives, and will constitute a record of the production of the company. Copies of the pamphlet can be obtained upon request.

NOTES.

Otto Gas Engine Works.—This company announces change of address from 360 Dearborn St. to Room 1203, 357 Dearborn St., Chicago, Ill.

Railway Materials Company.—This company announces that after May 1st its New York office will be located at the Washington Life Building, 141 Broadway.

Star Brass Manufacturing Company.—The New York office of this company has been removed from 38 Cortlandt St. to 70 Cortlandt St., where larger quarters are available.

Fairbanks-Morse and Company.—The San Francisco office of this company is now temporarily located at 969 Broadway, Oakland, Cal., where they will remain until able to return to their previous location in San Francisco.

Chicago Pneumatic Tool Company.—The quarterly report recently issued by this company for the first quarter, 1906, shows the profits for that time to have been over $233,000, leaving a balance of nearly $95,000 to be carried to surplus. The surplus of the company is now nearly $606,000. It is stated that the business for the month of April was about 10 per cent. in excess of the same period last year.

Test of Falls Hollow Staybolt Iron.—The following is the average result of a test of 16 samples of Falls Hollow staybolt iron, taken from regular stock, by the Baldwin Locomotive Works. The iron was 1 in. outside diameter and 3/16 in. inside: Tensile strength, 50,833 lbs. per sq. in.; elongation, 32.33 per cent.; reduction of area, 49.1 per cent.; threading test, O. K.; double bending test, O. K.; vibratory test, the threaded specimens stood an average of 7,713 revolutions when subjected to a deflection of 3/32 in. and a tensile load of 4,000 lbs.; etching test shows the iron to be slab piled.

Falls Hollow Staybolt Company.—Messrs. Berger-Carter & Company, the Pacific Coast agents of the Falls Hollow Staybolt Company, who were formerly located at 34 Beale St., San Francisco, Cal., announce that they are now temporarily located at Third and Washington Sts., Oakland, Cal., where they have installed a complete new stock.

Heating and Ventilating Apparatus for the United Engineering Building.—The heating and ventilating apparatus of special construction which will be installed in the United Engineering Building, the cornerstone of which was recently laid on West 39th Street, New York City., is to be furnished by the B. F. Sturtevant Company, of Boston, Mass.

Niles-Bement-Pond Company Exhibit at Atlantic City.—During the Master Car Builders' and Master Mechanics' conventions to be held at Atlantic City, June 13-20, the Niles-Bement-Pond Company will have on exhibition and *in full operation* one of their extra heavy 90-in. driving wheel chucking lathes. This will afford an exceptional opportunity to observe this machine at work. Owing to its great weight it cannot be shown on the steel pier. They have therefore built a special booth, two minutes' walk from the Pennsylvania Station on New York Avenue, near Atlantic Avenue, where you are cordially invited to witness a demonstration of this machine.

Crocker-Wheeler Company.—Mr. H. C. Baker, formerly in charge of the Atlanta office territory of the Crocker-Wheeler Company, has started for San Francisco, where he will take charge of the Pacific Coast territory of this company. The offices at Fremont and Howard Sts., San Francisco, were completely destroyed by the recent fire; temporary offices have been established at 2611 Broadway. Mr. Baker will enter an active field of electrical development in which the company is already conspicuously established by its installation of 4,000 KVA alternating current generators in the plant of the California Gas & Electric Corporation. These machines, the largest gas-engine-driven alternators in the world, escaped damage in the recent disaster.

New Buildings and Equipment at Purdue.—In order to provide for the constantly increasing number of students, Purdue University is adding a number of new buildings and considerable new equipment. A new building for the school of civil engineering will be ready at the beginning of the next school year, as will also an addition to the electrical laboratory, which will enclose the test car Louisiana deposited with the University by the American Street and Interurban Railway Association. It will be equipped with an overhead travelling crane. The mechanical engineering laboratory will also receive considerable new equipment, which, in addition to much small apparatus, will include an Ingersoll Rand compound duplex air compressor, a 50-h.p. gas producer with gas engine, several smaller gas engines, an Allis Chalmers direct-connected engine and centrifugal pump, a DeLaval steam turbine and centrifugal pump, a 100-h.p. compound marine engine and all auxiliary apparatus.

Resorts for the Vacationist.—The passenger department of the Boston & Maine Railroad has, according to its annual custom, just issued an illustrated pamphlet (80 pages) which describes the resorts for the vacationist, reached via the Boston & Maine Railroad and its stage and steamer connections, and contains a list of the hotels and boarding-houses, with their rates and accommodations, in this territory. These resorts are divided, for convenience, into three classes, the mountain, the seashore and the river, lake and inland resorts. Information is given as to the stage and steamboat connections and in addition there is a large map of the territory considered, and also three small maps, St. Andrews, N. B., and vicinity, White Mountain Region and Mount Desert Island and vicinity. Copies of this publication, and also one on excursion rates and tours, may be had free upon application to the passenger department at Boston, Mass. The following booklets which give in greater detail a description of the different vacation sections, as well as those resorted to by the hunter and the fisherman, will be sent on receipt of two cents in stamps for each book: Fish and Game Country, All Along Shore, Among the Mountains, Lakes and Streams, The Valleys of the Connecticut and Northern Vermont, Hoosac Country and Deerfield Valley, Central Massachusetts, Merrimack Valley, Lake Sunapee, Lake Memphremagog and About There, Vacation Days in Southern New Hampshire.